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MILIARY LUNG DISEASE DUE TO UNKNOWN CAUSE*

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INTRODUCTION

IN THE spring of 1927, the United States Bureau of Mines, the Metropolitan Life Insurance Co., and the Tri-State Zinc and Lead Ore Producers Association agreed to maintain cooperatively a clinic at Picher, Oklahoma, for the study and control of silicosis and tuberculosis among the miners. Physical examination, including roentgen examination of the chest, is made of the men prior to employment and at least once yearly thereafter. More than 18,000 individuals have been examined. Early in the work an occasional case was encountered in which the roentgenograms appeared to show miliary tuberculosis; but in many cases the history was practically negative, without symptoms, and, with two exceptions, all subjects were apparently healthy.

Grateful acknowledgment is made to Dr. A. J. Lanza for his interest and assistance in securing information in regard to similar cases, to Dr. Charles Thom, of the United States Department of Agriculture, for his advice and valuable work in identifying the fungus, and to Surg. R. E. Dyer, of the National Institute of Health, United States Public Health Service, for preparing antigens used in the skin test.

The following is a summary of 125 case histories.

PERSONAL DATA

Age. The cases ranged in age from sixteen to sixty-nine years. A tabulation by ten-year groups shows that 3.2 per cent were under twenty years of age, 36 per cent were between twenty and thirty, 35.2 per cent between thirty and forty, 16.8 per cent between forty and fifty, 7.2 per cent between fifty and sixty, and 1.6 per cent were sixty or over. The greatest number of cases occurred between twenty and thirty years of age and the next greatest between thirty and forty years. These figures indicate that the greatest number of cases occurs in the years in which adult tuberculosis is most common.

Race. With one exception, an Indian, the subjects were all white, native-born Americans. The majority were born and reared in the vicinity of the mining field. A tabulation of the places of birth shows that about 90 per cent were born in Missouri,

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Oklahoma, Kansas, Arkansas, and Illinois. Most of the subjects came from rural districts or had spent several summers in the harvest fields.

Family History. Although the study covers 125 cases, the family histories of only 54 were secured in detail. These were tabulated and results are shown in Table I.

TABLE I

Member of family	Living	Dead	Cause of death (per cent)													
			Senility	Diseases of heart	Paralysis	Accidents	Pneumonia	Tuberculosis	Influenza	Typhoid fever	Nephritis	Cancer	Childbirth	Whooping cough	Measles	Cause not given
Father	47.0	53.0	3.9	5.8	—	1.9	13.7	5.8	1.9	7.6	1.9	—	—	—	—	9.5
Mother	54.8	45.2	5.8	5.8	1.9	—	7.6	1.9	1.9	—	—	—	1.9	—	—	15.6
Brother	63.0	37.0	—	—	—	7.4	3.7	3.7	3.7	5.5	—	—	—	3.7	3.7	3.7
Sister	70.4	29.6	—	—	3.7	1.8	1.8	—	1.8	1.8	—	1.8	—	3.7	3.7	9.2

Table I shows that the death rate from pneumonia is twice as great for fathers as for mothers and the death rate from tuberculosis is three times as great for fathers as for mothers. The deaths from tuberculosis in the families of the subjects under discussion are approximately the same as in the families of metal miners in this district. Further, the number of subjects themselves who have had pneumonia is approximately 30 per cent higher than in miners.

Previous Illnesses. The subjects gave histories of the usual diseases of childhood and adolescence. In only two instances, namely, pneumonia and influenza, did the number having such diseases exceed the normal for the mining industry in this locality. The other respiratory diseases, such as pleurisy, hay fever, asthma, and acute bronchitis, were approximately 50 per cent less frequent than among the miners.

Occupational History. The first reaction on reading the roentgenograms of these men was that their condition was associated with mining; but on closer study of the histories it was found that 8 per cent had never worked in or around mines and that 3.2 per cent had worked on farms all their lives. Of those giving a mining history, 18.1 per cent had worked less than one year in the mines; 18.1 per cent from one to two years; 12.7 per cent from three to four years; 12.8 per cent from five to six years; 6.3 per cent from seven to eight years; 6.3 per cent from nine to ten years; 5.3 per cent from eleven to twelve years; and 20 per cent over twelve years.

The past occupations given by the men show that 54.4 per cent had been farmers, while only 23 per cent of all the miners in the district came from farms; that 12.8 per cent had been in school; and 31.2 per cent had been oil-field workers, pulp-mill workers, mechanics, and teamsters. With but two exceptions, the farms from which the men came were located in the wheat belt. The two exceptions were farms raising corn or alfalfa. The subjects who had not worked on farms came from agricultural communities and, with but one exception (a pulp-mill employee), from sections producing large amounts of wheat and hay.

Symptoms. Many of the subjects (65.6 per cent) gave no symptoms at all. Of the remainder (34.4 per cent), the following percentages gave the symptoms stated: Cough, 53.3; dyspnea, 62.6; expectoration, 18.5; hemoptysis (blood-tinged mucus), 11.6; loss of strength, 39.4; loss of appetite, 13.9; night sweats, 6.9; fatigue, 3.1; and pain in chest, 18.5.

A study of the roentgenograms and histories of an investigation of miners' phthisis, carried out in this district in 1927, revealed 6 subjects with the undiagnosed condition. Their symptoms and roentgen findings have remained about the same, except in one case which showed some improvement. Observation on the cases to date indicates that many cases have no symptoms; but when symptoms are present the most common are dyspnea, cough, and the expectoration of blood-tinged mucus. The symptoms apparently remain stationary, or tend toward a slight improvement.

Physical Examination. The records of the physical examinations show that 87.2 per cent of the subjects were apparently healthy; 12.8 per cent pale or emaciated; 65.6 per cent were robust; 12.8 per cent fair; and 21.6 per cent not given.

The weight of the subjects ranged from 112 to 187 pounds (with clothes on), averaging 150.1 pounds. They gave their usual weight as from 125 to 185 pounds, averaging 151.4. A study of the histories shows that at the time of examination 12 per cent were under their usual weight by 10 or more pounds, and 2.4 per cent were underweight by 20 or more pounds. One subject showed a gain of 5 pounds.

The height of the subjects varied from 60 to 75 inches, averaging 68.7 inches.

The pulse rate of the subjects averaged 83 per minute taken before exercise and 88.3 per minute taken after exercise (exercise consisted in stepping on a chair twenty times in 30 seconds). The pulse rate averaged 5.3 beats above normal after the subjects had rested for two minutes; in 56.1 per cent of the subjects it did not return to normal within two minutes, in 23.4 per cent it returned to normal, and in 13.5 per cent it dropped below normal within two minutes. The reaction of the remaining 7 per cent is not stated.

The respiration averaged 17.8 per minute before exercise and 19.8 after exercise (exercise the same as above), an increase of two respirations per minute after two minutes' rest; 47.3 per cent did not return to normal after two minutes' rest; 27.4 per cent returned to normal, and 12.1 per cent dropped slightly below normal. The reaction of the remainder was not stated. The respiration and pulse rate after exercise indicated some dyspnea in approximately one-half of the cases.

The average blood pressure was 126.9 mm. systolic, 79.6 mm. diastolic, and 47.3 pulse pressure. The blood pressure of 8 per cent of the subjects was above 150 mm. systolic. Four subjects had a low blood pressure (below 100 mm.).

Examination of the eyes, ears, and teeth disclosed little variation from the other males of the district of the same age groups.

The lung expansion varied from $\frac{1}{2}$ inch to 6 inches, averaging 2.8 inches. In 4.8 per cent the expansion was 1 inch or less; in 29.6 per cent, it was from 1 to 2 inches; in 37.2 per cent, from 2 to 3 inches; in 19.6 per cent, from 3 to 4 inches; and in 8 per cent, over 4 inches (one 6 inches). The average lung expansion corresponds closely to that of miners with silicosis uncomplicated with tuberculosis. First degree silicotics have a lung expansion of $2\frac{1}{2}$ to $3\frac{1}{2}$ inches, second degree 2 to $2\frac{1}{2}$ inches, and third degree 2 inches or less, averaging about $1\frac{1}{2}$ inches.

Inspection of the chests showed that 88.8 per cent were normal in shape, 3.8 per cent were flat and 6.3 per cent were barrel shaped. Four per cent had supraclavicular retractions and 2 per cent had sternal retractions. In each instance, the retractions were marked, especially in the cases with sternal retractions. This condition was very noticeable in these cases, but was not considered to be associated with the disease under discusssion.

Palpation showed 3.2 per cent with a decided increase in vocal fremitus over the entire chest. Two per cent showed diminished fremitus over the entire chest.

Percussion of the chest showed that 8 per cent had a slight dullness on one or both sides. This dullness was located in the upper section of the chest in the majority of cases.

The physical signs found on auscultation varied considerably in the different individuals, resembling closely the signs occurring in silicosis. The breath sounds in 48 per cent of the cases were harsh, rough, bronchial, or bronchovesicular in character over the entire chest; 8 per cent were harsh and rough in the upper half and weak in the lower half. The voice sounds in 6.6 per cent of the subjects were increased, more often in the upper half of the chest.

Râles were found in 23.2 per cent of the cases; in 13.4 per cent at the bases of the lungs; in 5.8 per cent at the apices, and in 4 per cent they were scattered. When râles were found, they were usually of the moist, mucus type. Three cases had semifine persistent râles heard at the apices, after an expiratory cough; in two of these cases the roentgenograms showed some evidence of active tuberculosis. In only 4 cases did the râles persist after coughing.

The heart examination was negative in all cases.

Roentgen Findings. A study of the roentgenograms shows a decided enlargement of the hilus shadows in 91.2 per cent of the cases and a slight enlargement in 7 per cent. The shadows are very dense and in 15 per cent of the cases contain one or more large calcified spots in the hilus. In one patient these spots were so numerous that the entire hilus appeared to be filled.

The linear markings, while somewhat more pronounced than in the average metal miner, are not as noticeable as in early silicosis. The markings extend to all parts of the lungs, but are more noticeable in the lower two-thirds, appearing to increase toward the bases. In 16.3 per cent of the patients, "budding," or early mottling along the bronchial tree, was noticed, indicating beginning silicosis. These patients had been working in lead and zinc mines for several years, and the fine mottling was probably due to silica dust.

The most characteristic finding was the large number of discrete, dense, shot-like spots scattered over the lungs. An effort was made to count the spots on flat films. The tabulation shows spots as follows: 28.8 per cent of the subjects had less than 25; 27 per cent from 25 to 50; 11.1 per cent from 50 to 75; 7 per cent from 75 to 100; 10.6 per cent from 100 to 200; 9.6 per cent from 200 to 300; 3.6 per cent from 400 to 500, and 1.6 per cent over 500. In 94 per cent of the cases from 55 to 95 per cent of the spots were located in the bases. They were scattered about equally over the lung area in 6 per cent of the cases. The cases can be divided roughly into two groups—those with large spots and those with small spots. The large spots vary in size from 4 mm. to 1 cm., averaging about 6 mm. They are not so numerous as the small spots, and appear to be more dense, discrete, and symmetrical. The large spots are mostly in the bases (average 80 per cent). The small spots vary from 1.5 to 5 mm., averaging 3 mm. They are fairly dense, round, and uniform. They are occasionally seen against the heart shadows, where they closely resemble lead shot of about a No. 8 size.

A review of the roentgenograms of the clinic shows that 29 of the cases have been returning at various intervals during the past two or three years. One case shows a decrease in the number of spots in the lungs, has gained weight, and is no longer short of breath. The other cases are about the same as when originally examined. The majority of the cases have been reëxamined from six months to one year apart, and in only 2 cases (tuberculosis cases) has any decided change for the worse been noted.

Laboratory Findings. A careful study was made of 88 cases. Two cases showed tubercle bacilli, and 7 had four plus Wassermann reactions. Blood counts showed the red blood cells to be normal in number, color and size. The white blood cells in all but two cases ranged from 5,000 to 10,000 per cubic mm., averaging 9,700. The two exceptions had a count of 10,900 and 14,000, respectively. The differential count showed the polymorphonuclear neutrophiles to range from 58 to 75 per cent, the large lymphocytes from 1 to 4 per cent, the small lymphocytes from 28 to 35 per

cent, the transitionals from 1 to 4 per cent, and the eosinophiles from 1 to 3 per cent. The bacteriological examinations of the sputum of the first 10 or 12 cases were considered to be negative. In an unstained smear a fungus was found, and 30 cases since examined all show a fungus. Media plates show an abundant growth of a superficial character after three or four days at 37° C. There are two types identified by Dr. Thom as *Aspergillus fumigatus fisheri* and *Aspergillus niger*. Dr. Thom suggested that antigens be prepared from the cultures.

An antigen of the *Asperigillus fumigatus fisheri* and later an antigen of the *Aspergillus niger* were prepared by Dr. Dyer of the National Institute of Health of the United States Public Health Service. These antigens were used in a dermal test to find out whether any sensitization occurred. Ten cases were tested with *Aspergillus fumigatus fisheri* and all showed negative results. An antigen of the *Aspergillus niger* was used in 6 cases and a marked positive reaction was obtained in each case. Each of these cases was tested at the same time with the antigen of the *Aspergillus fumigatus fisheri* and in one instance a weak reaction occurred.

An attempt was made to find the same fungi in the mouth or sputum of men working in or around the mines, and in one instance a similar organism was found. As the organism was not commonly found in miners, cultures of mine dust were made, with negative results.

Fig. 1. Case No. 11288. Roentgenogram shows hilus shadows enlarged, small amount of linear markings and small spots scattered over entire lungs.

Fig. 2 Case No. 10908. Male, aged twenty-five. Born in Arkansas; married; smokes. Previous illness: Measles. Occupational history: Six months in lead and zinc mines; before that, cotton farming. Present history negative. Physical examination shows appearance good; development robust; present weight, 143 pounds; usual weight, 141; pulse rate, 120, respiration, 14; blood pressure, 130/100; chest, 33/36; findings negative. Wassermann reaction, negative. Roentgenogram shows numerous calcified spots throughout both lungs.

TYPICAL CASE

A typical case is given in order to illustrate more clearly the findings, or rather the absence of physical findings.

Case No. 1128. A white male, aged thirty-nine, married and father of four children. Born in Virginia. Had never lived or associated with a tuberculous patient to his knowledge. Gave a history of having had mumps, scarlet fever, whooping cough, measles, diphtheria, smallpox, and influenza; denied history of any venereal disease.

Occupational History. Patient had worked as a shoveler in the lead and zinc mines for one year. Past occupation, wheat farmer for entire life. Gave a negative history for cough, shortness of breath, pain in chest, night sweats, and fatigue.

Physical examination showed the man to be of good appearance, plethoric, average develop-

ment, well nourished, weighing 160 pounds stripped, 70½ inches tall. Sitting pulse rate 72, respiration 18. After exercise (stepping on chair 20 times in 30 seconds) pulse returned to 74 and respiration to 18 after two minutes' rest. Blood pressure was 120 systolic, 60 diastolic, and 60 pulse pressure. Eyes negative, hearing negative, throat negative, nose negative, teeth clean and sound, with none missing, decayed, or artificial. No pyorrhea.

The chest examination showed an expansion of 3 inches, normal in shape; inspection, palpation, percussion, and auscultation were negative. This man was reëxamined 2 months and 18 days later, and the chest was negative for all findings.

The heart was negative, abdomen negative, no glandular enlargements, extremities negative; genitourinary system and skin, negative.

The roentgen examination shows hilus shadows enlarged, small amount of linear markings and small spots about 1.5 to 4 mm. in size scattered over the entire lungs (Fig. 1). The flat film shows 564 spots, discrete, symmetrical spheres, 70 per cent of which are at the bases of the lungs.

The laboratory findings show red cells 4,720,000, white cells 9,200, hemoglobin 87 per cent; differential count: polymorphonuclears 64 per cent, large lymphocytes 2 per cent, small lymphocytes 33 per cent, transitionals 1 per cent; Wassermann negative; sputum negative for tubercle bacillus but shows a fungus-like organism. The case is interesting in that it shows marked chest findings on roentgen examination, with very few symptoms of disease.

It was impracticable in the work at Picher, Oklahoma, to use the tuberculin test or to obtain autopsies on any of these subjects because of probable labor disturbance.

DISCUSSION

In making a diagnosis one would probably think of miliary tuberculosis, pneumoconiosis, calcium metastasis, or pneumomycosis. The present knowledge and conception of these diseases do not coincide entirely with the physical and roentgen findings of the cases under discussion.

Miliary Tuberculosis. The known high rate of tuberculosis in this district and the roentgen findings would suggest that the disease might be miliary tuberculosis. The cases, with two exceptions, appear healthy and show few, if any, symptoms or physical signs of miliary tuberculosis. The cases that have returned for reëxamination show that the condition has remained stationary in all cases except three, one showing some improvement and two having developed pulmonary tuberculosis.

Marlow[5] gives a brief review of 36 fairly authentic cases of miliary tuberculosis found in the literature. He calls attention to Northnagel's belief that many more cases recover than is realized, because the diagnosis is rarely made if the patient improves. More recently, Opie[6] has called attention to the same idea, emphasizing the fact that the condition is not always fatal. With the increasing frequency of more or less routine roentgen examination of the chest in some of the larger hospitals, he thinks we may expect to find more and more instances of inactive miliary tuberculosis and that it is possible that not many years hence the prognosis in generalized tuberculosis may be found fairly hopeful in an increasing percentage of cases.

Marlow states that the number of cases cited is not imposing, but that it need only be pointed out that the character of the disease is indefinite, as are the general opinions regarding it. Suggestive physical signs are rarely found; the story is vague, and the medical profession is educated to belief in the invariable fatality of the condition. The following is a summary of the cases Marlow found in the literature. A number of these are probably not true miliary tuberculosis although classed as such by the authors.

In 1860 Wunderlich reported a death from an intercurrent illness in a patient whose case had been diagnosed as miliary tuberculosis four months previously; autopsy confirmed the presence of the acid-fast infection. Six years later, Sick stated that he had found healed miliary tuberculosis in the lungs of a stonemason. As all the lesions were of the same size, he believed that they were probably not inhaled particles of stone. Burkart mentioned

instances of miliary tuberculosis in which the character of the tubercles furnished evidence that they had existed for a considerable time before death. In addition to these, Longcope, in a study of 19 cases of generalized tuberculosis, reported 8 that had a course sufficiently prolonged to be considered subacute or chronic. However, none of these cases lasted more than a year. Opie noted a case of healed miliary tuberculosis coming to autopsy as the result of *Streptococcus viridans* endocarditis. He concluded that although absolute proof of the nature of such lesions is impossible during life, in all probability they represent healed tuberculosis. He believed that miliary tuberculosis, contrary to the generally accepted opinion, occasionally takes on a chronic form and may heal with or without calcium deposit. Von Muralt reported 2 cases which eventually came to section as a result of meningeal involvement. In recent years the increased frequency of roentgen examination has brought to light more and more instances of miliary tuberculosis in persons not acutely ill. One of these cases was described by Northrup in a paper presenting 8 cases of generalized infection diagnosed by roentgen examination as miliary tuberculosis. Similarly, cases have been reported by Kahn, Baer, Stivelman and Hennell, Blaine, Bierman, Klingenstein, Pierson, Maendl, Wallgren, and Mason and Nather. Marlow calls attention to a few cases of particular interest, such as the case of Preston and Jeaffreson with its associated evidences of Mikulicz's disease. Middleton reported a case of coincident syphilis, but gave no comment upon the effect of antisyphilitic treatment. Kahn found typical roentgen evidence of miliary tuberculosis of the right lung only, and was able a year later to demonstrate tubercle bacilli in the sputum.

In a paper emphasizing the value of serial roentgen examinations of such patients Sante[8] reported 2 cases, one dying after an illness of seven months and the other after about three months' illness. In the first case roentgen examination revealed an extensive miliary tuberculosis of the lungs distributed in both lung fields. Autopsy revealed generalized miliary tuberculosis. Roentgen examination of the second case revealed numerous small, soft infiltrations, uniformly distributed throughout both lungs, the typical picture of miliary tuberculosis. Sante remarks that every roentgenologist has encountered instances in which numerous minute shot-like calcareous deposits are seen in the lungs. Their symmetrical generalized distribution leads one to think that they may be due to healed lesions of miliary tuberculosis. A considerable number of such cases has been encountered and an effort has been made to ascertain the cause. The age of the patient does not seem to be a determining factor, according to Sante, as he found the condition twice in children twelve years old. That the condition does not represent any active disease was evidenced by serial roentgenograms taken of a patient showing this condition in which no change was noted in the calcareous deposits during a period of nearly a year.

Sante considers that while this condition has been regarded as healed tuberculous lesions of a disseminated pulmonary type, there is no adequate reason why it might not represent a healed lesion of the generalized miliary type of tuberculosis. He had hoped that the chronic case he described, owing to the mildness of the symptoms, might prove to be of this type and that he would be able to obtain a complete series of examinations showing the course of the disease from the stage of first appearance of the tubercles to the stage of calcification. Only by such an observation will the true character of this condition be definitely established. Until this time he thought there was sufficient authority in the opinion of able pathologists and roentgenologists for a provisional diagnosis of healed miliary tuberculosis.

Pierson[7] describes 3 cases. In one case the healing proceeded by absorption rather than by calcification. In a case lent to him by Dr. Eugene Kilgore, the roentgenogram

showed a fine uniform mottling throughout the upper half or two-thirds of both lungs. A film taken eight months later for comparison showed essentially the same condition, evidently quiescent. Six months later the patient's left kidney and epididymis were removed because of tuberculosis; otherwise he remained well. In the third case described by Pierson, physical examination was negative except for the chest, which showed a few fine crepitant râles at the right apex and signs of cavity at left apex; roentgen examination showed calcified nodules scattered throughout all five lobes. There was a cavity at the left apex. This last case, according to Pierson, showed the picture of a disseminated tuberculosis throughout the lungs, which healed by calcification, except for a cavity at the apex which may have existed before this disseminated condition took place. In fact, in adult life generalized miliary tuberculosis develops by the breaking through of some focus, frequently a cavity, into the blood stream. Its arrest and healing in this case were due to there being present sufficient immunity to localize the disease. Whether or not any other organs became involved at that time and showed healed tubercles, he could not say, for it was not possible to make so extensive an examination.

Pierson calls attention to other cases of a diffuse tuberculosis in the lungs in which a blood or lymph borne infection appears quite possible, but these when localized in one or two lobes are more often due to the bronchopneumonic or contact method of implantation. The most common diseases to consider in differential diagnosis are diffuse bronchopneumonia, pneumoconiosis, and coccidioidal granuloma. A short period of observation will rule out the first; and with a history of such occupational hazards as produce the second, the diagnosis of miliary tuberculosis would be very unwise. Pneumoconiosis, when associated with tuberculosis, practically always leads to the massive bronchopneumonic type. Coccidioidal granuloma generally breaks down and the microorganisms are found in the sputum.

Blaine[2] calls attention to the paucity of clinical symptoms, which he explains as due to the fact that in the phlegmatic individual it is difficult to elicit any history of an acute sickness in the ordinary sense, as he is prone to overlook or underestimate the importance of a period in which he did not feel well, his appetite was not up to normal or he seemed to lack his usual "pep" for a few days or a week or two, and he may have paid no attention to such a physical decline, and, following this uncertain period, recovered his former more or less normal condition. On the other hand, the high-strung, or neurotic, type of person most often recalls such a period in which he had to lie down or go to bed for a few days, later getting along all right, often without recourse to the physician. In such cases one is less reluctant to believe that an acute miliary tuberculosis is a possibility. A rise in temperature may not be recognized by a person of the former group, who may often have an increase of 2 or more degrees without realizing it, while the latter invariably knows that he has fever. Headache, malaise, and the usual accompaniments of temperature increase are a part of the story of the more highly strung person, while the phlegmatic individual invariably fails to note such occurrences. Blaine mentions as one of the chief points in his observation that an active tuberculosis can be present in the intervening areas, but that, when these areas which lie between the individual dense shadows under discussion are of normal transparency to the roentgen ray, it is safe to assume this particular tissue to be normal, especially if there is no clinical evidence of a pulmonary disease at the time of the roentgen examination. He found a varying number of these lesions present in the different cases; in one case the multiple spots were so close together that very little of the lung field could be visualized, literally thousands of foci being evident; in another case, the foci were so far apart as to make it doubtful whether the case could be

properly considered a disseminated miliary tuberculosis. He reminds us that the term "miliary" usually refers to the size of the tubercle, and that there may be only a few of such miliary tubercles, or, on the other extreme, so many as to startle the observer when he views the case roentgenologically. Here enters the probability of an involution of the majority of the tubercles, a few only undergoing calcification. The individual lesion, however, is in both instances substantially the same. While it is true that the calcified tubercle is not in itself a positive sign of a preceding active tuberculosis, Blaine thinks that the greater incidence makes the probability so great that we may assume such to be the case.

In a discussion of Blaine's paper, the consensus of opinion was that there is no proof that these lung findings represent healed miliary tuberculosis, but that after all this seems the most reasonable explanation. Several cases were reported with roentgen findings closely resembling those seen in Blaine's cases. Pendergrass suggested the possibility that the miliary shadows are due to calcium metastasis in the lung, and Martin reported a case in which they were interpreted as calcified areas due to healed trichinosis.

Baldwin, Petroff, and Gardner[1] make the following statement in regard to "chronic miliary tuberculosis":

> As previously mentioned, tubercle bacilli must frequently be carried from the tracheobronchial or other lymph nodes, such as the mesenteric or cervical groups, to the great veins of the neck by the efferent lymphatic of these nodes, which discharge directly into the thoracic duct. Such a discharge is in the nature of an overflow; it is intermittent in character, and the number of bacilli is necessarily small. They will be distributed by the venous blood to the capillaries of the lung where most of them are retained and may originate fresh, isolated foci of disease.
>
> . . . Owing to the relative immunity of the tissues the small doses of bacilli originally disseminated do not immediately initiate progressive disease. Perhaps it may never occur, but as the result of trauma, intercurrent infection, or increased functional activity in a part, the small latent tubercle becomes inflamed and serves as a local source for more or less rapid extension by contiguity and by way of the organ duct system.

Although the roentgen findings in the cases at Picher are similar to those in miliary tuberculosis, the spots in these cases appear more uniform in shape and size, and are dense and shot-like in appearance. Assuming that the disease is miliary tuberculosis, the data indicate that the disease is far more common than thought to be at present, and that it may exist for years before appearance, symptoms, or physical signs develop sufficiently for a clinical diagnosis to be made. The data reveal relatively few cases with sufficient symptoms to cause the men to seek medical advice or to render them unfit to perform their usual work. Although the large number found in 18,000 men examined indicates that the disease is quite prevalent, the fact that no deaths from the disease have occurred in the group under observation for a period of from a few weeks to three years indicates that the death rate is low. If the disease is miliary tuberculosis, the data lead to the conclusion that an unfavorable prognosis in miliary tuberculosis should be made with caution.

Pneumoconiosis. The lead and zinc ores in this district occur in a hard flint-like rock, containing a high percentage of silica. The mining of these ores in some instances exposes the men to fine silica dust. The inhalation of this fine dust produces first degree silicosis in from three to fourteen years, depending upon the occupation and atmospheric dustiness. The first few cases of the group under discussion were found in miners and, at first, it was thought that the condition was silicosis in an atypical form. As the work of examining the men progressed, the companies required all men entering their service to have a physical examination prior to employment or shortly thereafter. Many of the cases under discussion were found in men seeking employment or who had been employed underground for

only a short time at most, and apparently mining work could not have caused the condition found. The generally healthy appearance, occurrence of few or no symptoms, and the occasional and often contradictory physical signs found in this group of cases correspond closely to the findings in silicotics. The cardinal symptom in both groups of cases is dyspnea on exertion out of proportion to the physical signs, appearance, and symptoms.

The roentgen findings in the two groups of cases are radically different. The roentgenograms in silicosis show more decided linear markings. The bronchial tree in the early stages shows along its course small mottled areas, sometimes referred to as "bronchial budding." These areas tend to coalesce into larger irregular areas of increased density as the disease progresses, so that in the third stage there may be large irregular areas of marked density, usually located in the bases or mid-section of the lungs. In the group of cases under discussion, the spots are regular, fairly uniform, shot-like in density, and do not tend to coalesce. The difference in the roentgen findings and the fact that the disease apparently occurs most often in men not associated with the mining industry and who have not been exposed to large amounts of silica dust lead to the conclusion that the disease is not due to the inhalation of silica dust.

Calcium Metastasis. The possibility of miliary calcification should also be considered. Sutherland[9] describes 38 cases selected from about 60,000 roentgenographic examinations of the chest made in the Mayo Clinic. The majority were from rural districts. The lesions he observed in the roentgenograms were multiple, miliary, calcified spots, varying in size from a pin point to 2 or 3 microns; they were round, discrete, and sharp in outline, were distributed through both lung fields, were seldom seen above the first interspace, and were generally more numerous toward the base. In number they varied from 8 to 10 large spots to innumerable miliary particles.

In his discussion of these cases Sutherland considers whether or not the diseases known to exist were adequate cause of the metastasis, as a majority of the patients had some lesion that theoretically could have been an important etiologic factor. However, in the cases in which there were definite lesions of bone, the lesions were of a type and duration that made sufficient solution of calcium to cause the secondary lesion improbable, in the majority of instances. The fact that the majority of the patients came from rural districts in which the calcium content of the water was known to be high, suggested a cause; but again there were large numbers from the same district with similar lesions who did not show any evidence of calcium metastasis. He thinks there is little doubt that many of these primary lesions, and to some extent the habitat, are factors in the oversaturation of the blood with calcium salts; but to this must be added some metabolic anomaly causing an imbalance that favors the precipitation of the calcium salts from the blood. Sutherland questions whether the term "metastasis" is appropriate in cases in which there is no evidence that the calcium has been absorbed from other tissues.

In his discussion of differential diagnosis Sutherland states that calcifications of the pleura are commonly confined to one portion and the lesions manifested by fibrosis; that calcification in the region of the hilus, which is often encountered, is seldom discrete; that pneumoconiosis in the diffuse form gives a much softer and more indistinct shadow than miliary calcification, with a tendency, as the condition advances, to the formation of conglomerate shadows, usually in the middle third of the lung field and toward the periphery, and that tuberculosis generally has associated evidence of a lesion of the lung tissue, with areas of irregularly shaped calcifications varying greatly in size. He states that clinically there is no syndrome indicative of the anomaly and that we are dependent on the roentgen ray for its discovery. He also

mentions the rarity of the abnormality and its usual lack of symptoms or grave consequences.

From the above description by Sutherland the disease found at Picher is apparently the same. Sutherland was unable to come to a definite conclusion as to the exact etiology.

Pneumomycosis. The disease may be a pneumomycosis. The data show that the condition under discussion is more common in farming than in other industries in the section of the country considered. All subjects except one were farmers, teamsters, feedmill workers, or residents of small agricultural towns where grain is marketed. Farmers are exposed to fungi in threshing wheat, baling hay, or handling various small grains. Cultures were made of the dust around one wheat thresher and abundant growths were obtained on each dish exposed. Four dishes were exposed in the separator, four in the wheat stacks, and two in the wagon hauling the grain. Each plate showed a growth of a fungus closely resembling the fungi isolated from the sputum of men with the disease. Apparently not all of the men working in the harvest fields contract the disease, since a large number of men examined who had had many years of experience around the harvest fields showed no evidence of it. It is well known that fungi may be found in the mouths of healthy people.

In an article on mold infections of the lung, Emerson[4] called attention to the value of making a complete examination of the sputum, as he thought that mold infections of the lungs, treated as tuberculosis, were by no means rare. In his summary of the literature, he stated that Bennet, in 1842, reported probably the first human case, and in 1856 Virchow demonstrated at the autopsy table the pulmonary lesion and the organism. Emerson stated that the endemic form is a primary infection due to the occupation of the patient. The earlier cases reported were of pigeon feeders, men who filled their mouths with grain, from which location the young pigeons would pick their food, and of hair combers, who used rye flour in cleaning the hair and worked in an atmosphere so full of infectious dust that a cat was the only animal that could survive in company with them.

According to Emerson, *Aspergillus fumigatus* may cause necrosis, inflammation, or suppuration, but in the last mentioned lesion very little liquid pus is formed. He divides cases of mild infection of the lungs into three groups: simple bronchitis, chronic interstitial pneumonia, and pseudotuberculosis with cavity formation. Patients with this chronic bronchitis may suffer for years and yet have little disturbance of general health. In one case reported by Osler the patient had for twelve years expectorated, at intervals of every few weeks, masses the shape and size of a bean which consisted entirely of the mold growth. Other cases of primary chronic membranous bronchitis, expectorated casts of the larger bronchi as long as 6 centimeters. In the second group, the chronic bronchitis terminates in a chronic interstitial pneumonia. The symptoms are those of severe chronic diffuse bronchitis with harassing cough and considerable dyspnea, due to emphysema and pulmonary consolidation and resulting contraction of the chest. The third group is that of cases of pseudotuberculosis, in which the symptoms and lesions resemble those of tuberculosis—pulmonary hemorrhage, digestive disturbances, fever, night sweats, emaciation, and death. The cavaties may be the size of an apple.

Castellani[3] states that diseases of the bronchi and lungs associated with the presence of fungi in the sputum are not at all rare. He discusses these conditions under the terms of bronchomycosis which he classified as follows:

1. Due to yeast-like fungi, viz., fungi of the types *Monilia*, *Cryptococcus*, *Saccharomyces* and *Endomyces*.

2. Due to filamentous fungi: (*a*) of the slender type, viz., fungi of the types *Nocardia*, *Anaeromyces* and *Vibriothrix;* (*b*) of the larger type, i.e., *Oidium* and *Hemispora;* (*c*) with characteristic fructifications—*As-*

pergillus, *Penicillium*, *Mucor*, *Rhizomucor*, *Acremoniella*, etc.

Castellani states that the symptoms are somewhat similar whichever fungus is the etiologic factor. In mild cases there are signs of slight bronchitis with mucopurulent expectoration in which the fungi are found. In severe cases the patient presents all the symptoms of phthisis.

The investigation at Picher, as well as a search of the literature, has failed to reveal sufficient knowledge of this malady to warrant a statement that it is one of the four diseases mentioned, but the evidence is sufficient to conclude the disease is more prevalent than it has been thought to be, and for this reason it is worthy of serious study.

SUMMARY

1. About 125 cases of typical miliary lung disease are described as having been found by roentgen examination among 18,000 individuals during routine physical examination.

2. A majority of the cases did not have sufficient symptoms to cause them to stop work or to seek medical aid.

3. The most characteristic finding was a large number of discrete, dense, shot-like spots scattered over the lung areas.

4. Tubercle bacilli were present in only 2 of the 88 cases in which an examination was made of the sputum.

5. Unstained smears of 31 cases (all those examined) were positive for fungus.

6. Two types of fungi were identified—*Aspergillus fumigatus fisheri* and *Aspergillus niger*. Ten cases tested with antigen of *Aspergillus fumigatus fisheri* gave negative reaction; 6 cases tested with *Aspergillus niger* all gave positive reaction.

7. Thirty-eight cases reported by Sutherland as "miliary calcification of the lungs" probably represent the same condition as found at Picher.

8. These miliary calcifications may be due primarily to fungous infection.

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DISSCUSSION

Dr. Henry K. Pancoast, Philadelphia. I am sorry Dr. Sayers did not show some of his really bad cases. I have seen quite a number of them and I know those shown are only minor ones. I induced Dr. Sayers to present this paper here because his previous communication was rather buried in the reports of his department and would not come to the attention of very many roentgenologists. We all believed in calcium metastasis many years ago. Later, we regarded these cases as due to healed miliary or bronchopneumonic tuberculosis. That this does occur, I feel certain. My reason for believing it does occur was the opportunity to watch an individual who had tuberculosis of a miliary or a general bronchopneumonic type, and who afterwards got well, and the calcification occurred in the lesions of that individual.

It is evident that we shall have to modify our recent belief that all calcification which occurs in the lung and the tracheobronchial lymph nodes is of tuberculous origin, because in Dr. Sayers' cases it is not of tuberculous origin in a large number of instances. I am sure that this

condition, if it is found really due to a mycotic type of infection, is rather an entity.

Dr. George W. Holmes, Boston. The cause of miliary-like processes seen in roentgen films of lungs is a problem of increasing interest. We are seeing this sort of condition more often than we used to and have found a much greater variety of causes. We have had some cases of Aspergillus in our clinic but they haven't shown this picture. Perhaps we did not observe them long enough. We have had some cases of the type described that came to autopsy. I will show a slide of one of these cases.

(Slide). This slide, as you see, presents an appearance similar to those shown by Dr. Sayers and Meriwether. At autopsy small calcified nodules were found scattered throughout the lung, and although the pathologist would not make a positive statement, he did say that it was probably tuberculosis. I think it is fair to assume that this case was one of calcification due to tuberculosis.

(Slide). This slide is presented to show the variety of conditions which can produce a similar picture. It is not calcification but capillary bronchiectasis and at autopsy the smaller bronchi and the alveoli were dilated and filled with secretion. There was nothing particularly wrong with any other part of the lung.

Dr. A. Howard Pirie, Montreal, Canada. If these persons with this calcified miliary tuberculosis, as we call it at present, really had miliary tuberculosis, they must have had a very severe illness at one time, because we diagnose miliary tuberculosis frequently by roentgen examination, and the patients always die. Did these patients have a very severe illness previously which was really miliary tuberculosis, followed by calcification? I rather favor the idea that what we now call calcified miliary tuberculosis is not really due to miliary tuberculosis.

One sees a similar condition sometimes in bones. You see condensed areas in bones of which you can get no previous history of tuberculosis, and yet you find patients with condensed areas in bones which correspond with calcification of the miliary nature in the lungs. Is it not the same disease affecting the bones which affects the lungs and is followed by this tuberculosis?

Dr. L. R. Sante, St. Louis, Mo. I was much interested in Dr. Sayers' demonstration of disseminated calcifications in the lung. It may seem a strange coincidence that we also at one time had our attention directed to the possibility of these cases being due to inhalations of air laden with lead dust. In the discussion of Dr. Blaine's paper on the subject some years ago, I called attention to the fact that we had had a number of these cases that had been in association with the inhalation of lead dust. We were forced to abandon the idea, however, owing to the inability to establish exposure to lead dust in a great majority of our patients. Thinking that possibly these might represent tuberculous nodules and that there might be some change, we admitted one of these patients to a tuberculosis sanatorium, isolated him and observed him over the period of a year. There was absolutely no indication of change of any sort in the appearance of the condition.

I may say also that in discussion of a similar case a number of years ago, Dr. Eugene L. Opie declared that he had autopsy material showing these nodules not confined to the lungs but disseminated in all the organs of the body. He gave his opinion that this was undoubtedly evidence of a healed miliary or disseminated tuberculosis and that our ideas must be changed from those we had previously had of an absolutely fatal termination in all cases of miliary tuberculosis.

I think, however, that until actual tubercle bacilli are isolated from these nodules, until someone follows a patient of this sort from the inception through the stage of active disease to its terminal calcification, and then has an autopsy, the cause will not be definitely and thoroughly proved.

Dr. Henry J. Walton, Baltimore, Md. I recently saw a patient who showed roentgenographic changes in the lungs similar to a number of those which have been demonstrated here. This particular case is of interest on account of the autopsy findings.

The patient was a woman thirty-five years of age who entered the University Hospital to be treated for an exophthalmic goiter. The roentgen examination of her chest showed that both lungs were studded with small dense miliary-like shadows which I called healed tubercles. On account of these findings her history was gone into very carefully to determine whether or not she had previously had tuberculosis, but her history was negative. In due time a thyroidectomy was performed. She was apparently making a good recovery when she died very suddenly of heart block.

At autopsy, the lungs, liver, spleen and kid-

neys were found to be studded with very small, partially calcified nodules which the pathologist called tuberculous, though they have been unable to isolate the tubercle bacillus.

Dr. Albertus Cotton, Baltimore, Md. I would like to add one more case to the number that have been presented to show that cases of miliary tuberculosis do not always die, although as Dr. Pirie states, we expect them to whenever we make the diagnosis.

About three years ago I was treating a little girl for dorsal Pott's disease. She had been treated on a Bradford frame with hyperextension for a number of months and seemed to be doing well. Before deciding to change to ambulatory treatment with cast, a preliminary roentgen examination of the spine and lungs was made. The films showed a definite miliary tuberculosis in both lungs, a typical picture, also tubercles in the spleen. After roentgen examination our preparations for the cast were abandoned. The child was put back in bed without a frame and the parents were told that the child had miliary tuberculosis and would probably die in a few months. A few weeks after that the child developed pleurisy with effusion, a temperature with cough and dyspnea and the symptoms characteristic of miliary tuberculosis together with pleurisy. We felt we were good prognosticators and told the parents that the patient would certainly not live very long. In spite of our prognosis, the patient continued to improve. The fluid was aspirated and the patient was placed on a fracture bed and given supportive treatment and heliotherapy. At the present time the child is clinically well. The tuberculosis in the spine has been arrested. The child is wearing a brace and has been sent to her home on the eastern shore of Maryland. The last roentgen examination showed the miliary tuberculosis in the lung still present, also in the spleen. The nodules were more discrete and more dense with considerable calcification.

This is just another case report to add to the evidence that miliary tuberculosis cases do get well and that there is a type known as chronic miliary tuberculosis.

In connection with this discussion, I would like to call attention to the resemblance of chest films of children after lipiodol injection to those with miliary tuberculosis. Several years ago a chest film was sent to me for diagnosis. My first impression was miliary tuberculosis. More careful examination, however, showed that the small areas of increased density scattered throughout the lung were much more pronounced on the right side. Inquiry made into the history of the case disclosed the fact that the film was taken after lipiodol injection. The resemblance to miliary tuberculosis was very marked except for the fact that most of the "pathology" was in the right lung. Lipiodol injections of the bronchi in children are diffused through the alveoli as well as the bronchial tree. The resemblance to miliary tuberculosis is very marked. In the absence of knowledge of a lipiodol injection, the fact that the "mottling" or small areas of increased density are more marked on the right than on the left side should prevent an error in diagnosis.

Dr. Sayers (closing). Dr. Pancoast's statements are correct. He has seen a great many of our negatives not only of this disease but of the others.

Dr. Pirie wanted to know if there was any history of illness among these cases. Many of these cases have no history of illness at all, that is, they don't have any serious illness. There just isn't any in their past history. They deny any serious illness of any character. The men we have known for five and six years have not been sick during that period. We have seen one or two cases before they had any of these spots and have seen them after they developed them, and they had really no serious illness during the time. One had a very mild illness during the time.

We had a woman and her daughter. They were not in the series I described. They went out on a farm and were there for about two years, I believe, and they both came back with somewhat different history, but both showed a few of these nodules such as we see here. Whether it occurs in the other parts of the body we do not know. We have not x-rayed the other parts of the body. This was just found on routine examination.

As to Dr. Sante's statement in regard to lead, many of these people have not been in lead mines at all, but have been only on farms and have come from the farms to get jobs in the lead and zinc mines. We would be unable to connect many of these with lead in any way.

So far as we can see, the only thing in common is a fungus which is present in all the cases that we have examined. Whether that is the cause of it or not, of course we don't know. We think there may also be a number of the fungi. The case I mentioned from Wilmington

was due to a Monilia; it was not due to Aspergillus.

We have been unable to get autopsies. We have only had one person die out of the 125 cases described. He was killed by accident. Dr. Meriwether tried to get an autopsy, but was unable to do so.

Dr. Cotton called attention to a case and these may be due to the same cause, and a number of them may be miliary tuberculosis. Of course, we are not certain. We have not been able to find tubercle bacilli in any of the cases except the two which were open tuberculosis. We have tried to prove experimentally that they are due to the fungi, but we are unable to do so up to the present time.

A DEMONSTRATION OF THE LYMPHATIC DRAINAGE FROM THE MAXILLARY SINUSES*

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AN UNUSUAL opportunity has come to me for the observation of the lymphatic drainage from the maxillary sinuses. The roentgen films which demonstrate this

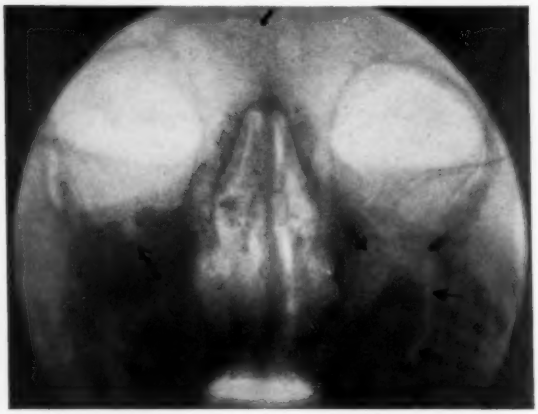

FIG. 1. Shows the maxillary sinuses injected with lipiodol on December 14, 1930. There is a small filling defect in the upper anterior portion of the upper anterior wall of the maxillary sinus which has the shape of a papilloma. It corresponds approximately to the location of the infraorbital nerve canal. Because of its sharp localization, it hardly seems likely that this is the cause of any general infection. The left maxillary sinus shows displacement along the outer border which is more likely due to a hyperplastic sinusitis, and is evidence of disease.

condition where shown before the Philadelphia Roentgen Society on April 2, 1931, and aroused considerable interest. Therefore, it seemed to me that it might also be of interest to the rhinologists.

On February 25, 1931, Mr. R.M.H., aged thirty-four, was referred to me by Dr. Luther C. Davis of Fairmount, W.Va., for the treatment of a general lymph gland enlargement which had been diagnosed microscopically as lymphosarcoma. During eight years, he had suffered from vague general pains, and for several months from more severe pains in his neck, which were associated with enlargement of the lymphatic glands in the neck. These glands were from 1 to 2 cm. in diameter. There were also some enlarged glands or lymph nodes in each axilla, each groin, and in the mediastinum. A lymph node had been excised from the groin while he was in Fairmount, and the pathologist reported lymphosarcoma.

I found a rather uniform enlargement of the lymph glands, including the mediastinal, but these did not have the characters of either lymphosarcoma or Hodgkin's disease. The specimen, previously removed, was re-examined by Dr. Eugene Case who could not find any evidence of lymphosarcoma, lymphatic leucemia, or Hodgkin's disease. He concluded that it was an inflammatory condition.

Blood examinations by Dr. John Kolmer showed no evidence of lymphatic leucemia or Hodgkin's disease, and the Wassermann and Kahn tests were negative for syphilis.

General examination showed some evidence

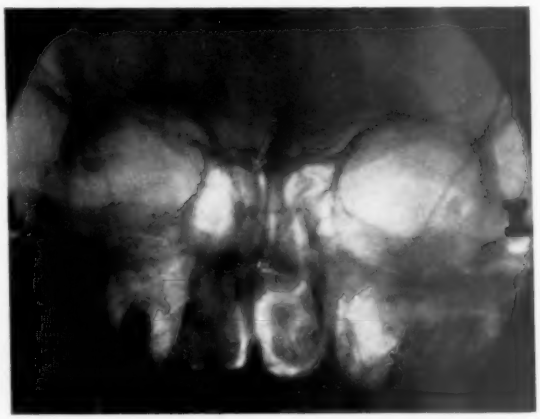

FIG. 2. Roentgenogram taken February 28, 1931, or approximately ten weeks after the lipiodol injection. This shows a pocket of retention, located in the posterior portion of the right maxillary sinus, as is indicated in the lateral view (see Fig. 4). This film also shows some evidence of opacity of the right ethmoid cells, but the maxillary wall seems to be fairly healthy. This film also shows deposits of the lipiodol scattered through the lymph spaces. Note especially the deposits on the outer portion of the orbital areas.

* Presented before the Section on Otolaryngology of the College of Physicians of Philadelphia, January 20, 1932.

of infection in the lymphoid tissue in the former region of the tonsil. Therefore these areas, and all of the lymphatic areas, were treated by irradiation which was followed by a complete recovery.

The abstract of the history of this case is given here because it is barely possible that the findings which I present do not represent the normal physiology of these lymphatics. Even so, I believe that it is fair to assume that I am demonstrating the probable normal anatomical distribution of these lymphatics. The normal physiology, as well as confirmation of these findings, is a matter for future investigations.

Of special interest to rhinologists, in this case, is the history that during the search for some focus of infection on account of the glandular enlargements in the neck, *the maxillary sinuses were injected with lipiodol on December 14, 1930.* A small filling defect was thereby shown in the roentgenogram, located in the region of the right infraorbital canal. It was about 4 mm. in diameter. An operation had been advised but was refused. He was then sent to me on February 25, 1931. During my roentgen examinations made approximately ten weeks after the lipiodol had been injected into the maxillary sinuses, I found the left maxillary sinus empty and normal in appearance. In the lower posterior portion of the right maxillary sinus there was retained a globule about 1.5×1 cm.

Fig. 3. Roentgenogram taken on February 28, 1931, with the central ray passing above the base of the skull, shows the distribution of the lipiodol extending as high as the zygoma and projected through the outer orbital space. It has seemed remarkable that this lymphatic absorption should extend upward as well as downward.

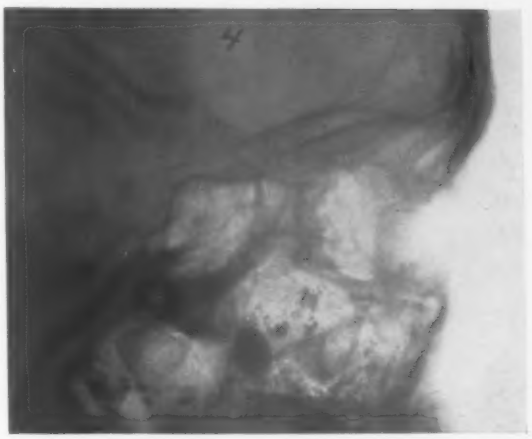

Fig. 4. Lateral roentgenogram taken on February 28, 1931, showing the sinuses and the distribution of these deposits of lipiodol extending definitely above and posterior to the maxillary sinus.

The most interesting findings, however, were *small scattered deposits of lipiodol*, from 2 to 5 mm. in diameter, in the lymph spaces extending from the zygoma to the clavicle on each side, but scattered also across the submental and sublingual region. On the left side these deposits can be traced exactly to the entrance into the thoracic duct and on the right side to the entrance into the jugular and the subclavian at their junction. Below this point it has not been recognized at any time. Evidently after reaching the thoracic duct the lipiodol is eliminated promptly.

The most dense accumulations are located between the mandible and the cricoid cartilage. All of these deposits, and presumably all of the lymphatic drainage from the maxillary sinuses, are located anterior to the spinal column, and it does not seem to extend into the posterior deep cervical lymphatics. I was especially surprised to find the lipiodol absorption extending upward as high as the zygoma. This may explain the tenderness and swelling seen in the zygomatic and temporal region in severe maxillary sinus infection.

Fig. 5. The anteroposterior view of the entire accessory sinus and neck area taken March 11, 1931, shows an extensive distribution of lymph spaces in the tissues on each side of the face, extending downward in the neck, and on the left side exactly to the middle of the shadow of the clavicle, which corresponds to the position of the entrance into the thoracic duct. It should also be noted that there is a considerable distribution of the lipiodol in the submental region. It also shows the total absence of any lipiodol or lymph spaces below the clavicle, which indicates definitely that on the left side, the lymph is drained directly into the thoracic duct at this point, and on the right side its termination at the entrance of the lymphatic duct into the vein.

Dr. Luther Davis kindly made for me additional films of this patient on October 1, November 1, and December 30, 1931. All of these showed relatively little change though there was some general reduction. The last films were made more than a year after the injection of the lipiodol into the maxillary sinuses. Even after this long time the lipiodol is distributed in the lymphatic spaces all the way from the zygomatic regions to the entrance into the thoracic duct.

This study seems to be of interest for the following reasons:

1. I believe it to be the first demonstration of the physiological distribution of the lymph spaces draining the maxillary sinuses.

2. It shows that this drainage extends upward as well as downward, or it would not have extended as high as the zygoma. Lipiodol is heavy and therefore easily drops downward by gravity. The extension toward the zygoma might be explained by the effects during sleep, but even at night the head is usually raised by a pil-

Fig. 6. A lateral view of the sinuses and neck taken on March 2, 1931, ten weeks after the lipiodol was injected. There has been practically no change as compared with the month before.

low. The spaces can be easily traced from the zygoma to the thoracic duct.

3. It is shown that at least lipiodol does not accumulate in the lymphatic glands and one does not recognize the location of the glands, such as is seen in the anatomical illustration. It had been my impression previously that any material absorbed would accumulate more or less as a deposit in the lymphatic glands, and therefore I would have expected these glands to stand out quite distinctly. Evidently, such drainage passes directly through the glands.

4. It shows how very slowly lipiodol is eliminated by absorption. A year has passed and it seems that another year will be required for complete elimination.

5. These studies would seem to indicate a possible method by which the lymphatic drainage from any cavity or tissue might be studied.

Fig. 7. An anteroposterior view taken on December 30, 1931, showing that there has been very little decrease in the general distribution and density of these lipiodol deposits in the lymph spaces.

Fig. 8. Lateral view made December 30, 1931, over a year after the original injection, still shows the wide distribution of these lipiodol deposits, with some general reduction in the total deposits, but the changes are relatively slight.

6. Such a wide and minute distribution of the lymphatic spaces would seem to explain the difficulty of dissecting the lymphatics, as such, at operations for malignant disease when metastasis has taken place by permeation. It also explains the extensive infiltration and recurrence which we often see after dissections for malignant disease. Sabin[1] speaks of tissue spaces containing a "tissue fluid" which should be distinguished from lymph. If these areas are only tissue spaces they at least drain definitely into the thoracic duct.

7. At present, we do not know how frequently such slow absorption of the lipiodol takes place after injections of the maxillary sinuses. I have not been able to find such experience recorded in the literature,

[1] Sabin. Harvey Lecture, Series IX, New York, 1915–16.

and in several other cases in which we have searched for such late effects they have not been shown. Generally, the lipiodol escapes rather rapidly through the natural ostia.

8. That the patient recovered and has remained well indicates that this retention of lipiodol in the tissues has done no harm.

9. The rapid improvement in this case following irradiation of the infected pharyngeal tissue and of the various lymph nodes would seem to indicate that the restoration to health was due to the irradiation, and not to any medicinal effect from the lipiodol.

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PRIMARY BRONCHOGENIC CARCINOMA OF THE LUNGS

REPORT OF A NEW TECHNIQUE IN RADIATION THERAPY*

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WITH COMMENTS ON ENDOSCOPIC RADON IMPLANTATION†

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CARCINOMA of the lung is either increasing in frequency or it is being correctly diagnosed more often. The accepted forms of therapy have been either surgery or irradiation, or a combination of the two procedures. Good results have been reported from radiation therapy, but for the most part, the results have been discouraging. It is because of this that we wish to present a method which has been employed in two cases of carcinoma of the lung, and one case of carcinoma of the esophagus.

In 1928, one of us (Pancoast) asked Dr. Chevalier Jackson if it were not possible to introduce radon into a bronchogenic carcinoma by the aid of the bronchoscope. Dr. Jackson stated that such a thing would be possible and at that time and at subsequent interviews, it was decided that the ideal growths for treatment would be those arising from the bronchial walls which were pedunculated or had not invaded the underlying tissues. Such carcinomas are not infrequent and the density of the lung distal to the point of obstruction is usually due to atelectasis, drowned lung or abscess formation, and not due to infiltration from growth.

It has always been our feeling that carcinoma of the lung is best treated when there is close cooperation between the roentgenologist and the bronchoscopist. We have felt that the patient should have a bronchoscopic drainage of the affected part at least once a week in addition to the radiation therapy. This allows the removal of the infected material from the lung, affords a better opportunity for clinical improvement if the patient is toxic, and lessens the chance of abscess and empyema formation.

FIG. 1. Lesion involving the left lower lobe. This was wrongly diagnosed as encapsulated empyema. By bronchoscopic examination, a carcinoma of the left lower lobe bronchus was demonstrated with atelectasis and drowned lung distal to point of obstruction.

In April, 1929, we had an opportunity to treat a patient suffering from a carcinoma of the left lower lobe bronchus. Dr. Jackson, with the help of one of us (Pancoast), had devised a method of radon implanation which will be described later.

* From the Department of Radiology, Hospital of the University of Pennsylvania.
† From the Bronchoscopic Clinic, Hospital of the University of Pennsylvania.

Fig. 2. The lesion involving the left lower lobe is clearly visible. Note how the left dome is elevated due to atelectasis.

Case 1. H. T., white, male, aged fifty-five. Admitted to the Hospital of the University of Pennsylvania, Service of Dr. Chevalier Jackson.

Chief Complaint. Cough and a severe pain over the left lower chest.

Present Illness. During the past three months, the patient had been expectorating one-half cup of whitish phlegm. He developed shortness of breath and lost 15 pounds in weight.

Physical Examination by Dr. Stewart. Signs over the left lower chest suggesting thick fibrous pleurisy, pulling the heart and trachea to the left. There is no evidence of fluid or abscess formation.

Wassermann reaction and sputum examination, negative.

Roentgen examination showed an old encapsulated pleural collection left base, posteriorly (Figs. 1 and 2).

Bronchoscopic Examination. There was a small, firm, nodular mass, whitish in appearance, in the orifice of the left lower lobe bronchial stem. There seemed to be considerable secretion in the distal lung A portion of the growth was removed for biopsy and the secretion in the distal lung was aspirated

Pathological Report. Squamous carcinoma.

The patient was referred for deep roentgen therapy which was directed through two portals of entry, one anteriorly and the other posteriorly. Between November 14 and December 8, 1928, the patient received a 200 per cent saturation dose over each portal, the factors being as follows:

Distance, 50 cm.; portals, 17×17 cm.; filter, 0.5 mm. copper and 2 mm. aluminum; 600 ma-min. *The portals were located by placing the patient in the recumbent posture and outlining the area of the disease on the skin in this position.* This is an important consideration in treating malignancy of the lower lobes of the lung, because the domes of the diaphragm are displaced toward the head in the recumbent posture.

Another similar course of therapy was given from January 15 to 19, 1929, the factors remaining the same except that the dosage was 300 ma-min.

A subsequent roentgen examination showed very little change in the appearance of the lung.

A second bronchoscopy was done on March

Fig. 3. Radon tubes in situ at A.

28, 1929, and a considerable quantity of secretion was aspirated from beyond the stenosed area in the bronchus.

Another bronchoscopy was performed on April 2, 1929, and a roentgen examination made the same day showed some improvement in the appearance of the lesion.

On April 5, 1929, Dr. Chevalier Jackson implanted two radon tubes directly into the growth by the aid of the bronchoscope. Each tube contained 1.95 mc., making a dosage of 604.8 mc-hr. (see Figs. 3 and 4).

A roentgen examination made on April 8, 1929, showed the radon tubes in situ. There was considerable improvement in the appearance of the lung.

Another bronchoscopy performed April 12, 1929, revealed considerable regression of the growth into which the tubes had been planted.

During a period from March 18 to April 22 the patient received deep roentgen therapy, 200 per cent saturation dose, the factors and portals remaining the same as outlined above.

Additional bronchoscopic drainages were carried out on April 23, May 2, and May 9, 1929.

A roentgen examination made on July 8, 1929, showed the lung density still present but improved over that of the first examination.

Bronchoscopy performed on July 12, 1929, showed considerable improvement. There was a slight oozing of blood present.

Bronchoscopy performed on July 16, 1929, showed a similar appearance. There was no air going in or out of the lung.

The patient returned home, considerably improved, but has been lost track of and does not respond to any follow-up notices.

The second case in which this method was employed was an esophageal carcinoma which was pedunculated.

Case II. S. G., white, female, aged fifty-seven. Admitted to the Hospital of the University of Pennsylvania, April 7, 1929, Service of Dr. Chevalier Jackson.

Chief Complaint. Difficulty in swallowing solid food.

Present Illness. The difficulty in swallowing began in August, 1928.

Past and Family History. Negative.

Physical examination by Dr. Thomas Klein was essentially negative.

Roentgen examination by Dr. Manges, April 17, 1929, showed a slight tendency to spasm in the lower end of the eosphagus, and some slight irregularity that suggested a possible early malignancy.

Esophagoscopy by Dr. Chevalier Jackson, April 18, 1929: The esophageal mucosa in the thoracic portion was chronically inflamed but was not white or furred. The lower portion was

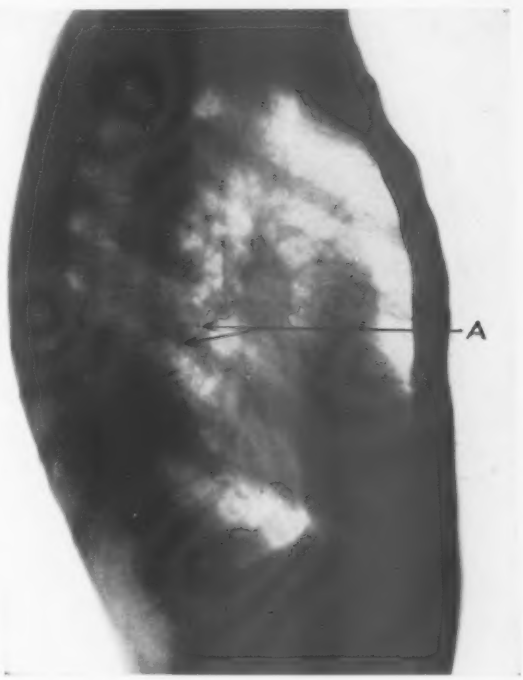

Fig. 4. Radon tubes in situ at A.

very much dilated and the folds were redundant. About 6 cm. above the hiatal constriction there was a bleeding nodule projecting in from the left side. A section was removed for microscopic diagnosis.

Pathological Report. Adenocarcinoma.

Comment. This case seemed to be the ideal type for treatment by direct implantation of radon into the growth. This was done by Drs. Jackson and Pancoast on April 29, 1929. The nodule was located by the esophagoscope and one radon tube containing 1.16 mc. was implanted.

Several esophagoscopies were done subsequently, the last on July 5, 1929, at which time Dr. Jackson made the following comment: "The nodule treated by radium has entirely disappeared and the surface at this location is epithelialized."

The patient was given two series of deep

FIG. 5. Bronchoscope and implanter in position.

roentgen therapy, cross-firing through two portals of entry over the lower end of the esophagus, the first April 29 to May 7, 1929, and the second series from July 1 to 9, 1929. The factors used were as follows: 50 cm. distance, 4 ma.; filter, 2 mm. aluminum and 0.5 mm. copper; field 17×17 cm.; time, 75 minutes.

The patient died on October 21, 1929, from metastasis to the abdomen. There was no local recurrence.*

The last patient which we wish to include in this series suffered from carcinoma of the lung.

CASE III. J. D. S., male, aged forty-six. Admitted to the University of Pennsylvania Hospital, July 29, 1930, service of Dr. Gabriel Tucker.

Chief Complaint. Productive cough.

Present Illness. He has had a cough for years which was productive of approximately one pint of foul smelling pus daily. He coughed up blood in 1923.

Past Medical History. Pneumonia in 1923. Otitis media, left ear. Three bronchoscopic examinations with a report of malignancy.

Family History. Negative.

Physical examination by Dr. T. Grier Miller showed the patient's condition to be good. There were signs over the right lower chest that suggested some interference with the air entering the right lower lobe.

Roentgen examination showed a lesion in the apex of the right lower lobe, the identity of which was uncertain.

Bronchoscopy for Diagnosis by Dr. Gabriel Tucker: In the right stem bronchus there was a reddish, irregular mass, projecting from the right lateral wall just below the orifice of the right upper bronchus. Lipiodol was injected bronchoscopically for study. Subsequent roentgen examination of the lungs showed no evidence of bronchiectasis.

Blood Wassermann, negative.

Bronchoscopy by Dr. Gabriel Tucker. A piece of the tumor was removed for microscopic study.

Pathological Report. Early carcinoma of the acinous-forming type, possibly of bronchogenic origin.

Bronchoscopic Treatment, August 13, 1929. *Radon* implantation. One tube containing 1.5 mc. was implanted under direct vision into the pedunculated mass. A roentgen examination was then made to discover the position of the

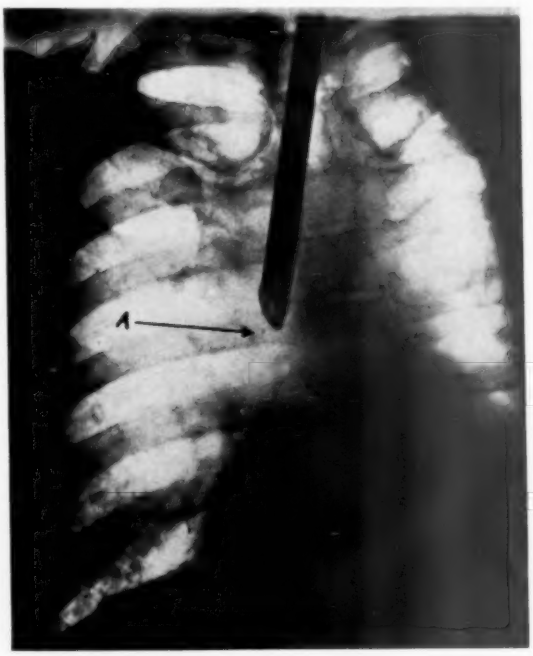

FIG. 6. Directly after implantation. Note radon at A.

*Since this report has been written, we have observed a second case of esophageal carcinoma in which radon seeds were implanted nearly two years ago, and at the present time there is no definite evidence of recurrence.

radon tube. It was found in the lower portion of the right lower lobe and had to be removed by the bronchoscope with the aid of biplane roentgenoscopic guidance. The radon tube was then re-introduced through the bronchoscope with roentgenoscopic control (see Figs. 5, 6 and 7). The radon implanter was then modified so that the depth of implantation could be controlled. Since that time all subsequent implantations have been made with the aid of roentgenoscopic guidance.

August 29, 1930, implantation of 1.5 mc. gold radon by direct and roentgenoscopic guidance.

November 7, 1930, implantation of 1.46 mc. gold radon by direct and roentgenoscopic guidance.

January 27, 1931, implantation of 1.48 mc. gold radon by direct and roentgenoscopic guidance. At this examination, the growth had practically disappeared and there was no obstruction to the lumen of the bronchus.

In addition to the above treatment, the patient has had four series of deep roentgen therapy directed through three portals of entry, cross-firing on the lesion and the lymphatics draining the involved area.

1. August 18 to August 22, 1930: 200 kv. peak, 4 ma., 50 cm. distance, 2 mm. aluminum and 0.5 mm. copper filters, three fields, 17×17 cm., time, 75 minutes.

2. September 4 to 15, 1930. Same as above.

3. November 11 to December 4, 1930. The factors were the same as above except 600 ma-min. were given instead of 300 ma-min. This represented 200 per cent saturation.

4. January 28 to February 19, 1931, 200 per cent saturation dose given.

COMMENTS

It has been recognized for some time that irradiation of tissues overlying cartilage ofttimes causes severe perichondritis which very frequently contraindicates further irradiation. The patient suffers severe pain and his condition is often much worse than before treatment was instituted. Because of this, we have been hesitant about implanting radon into bronchogenic carcinoma.

In the treatment of carcinoma of the lung, one should take advantage of every possible aid available. Our results using cross-fire deep roentgen therapy have been discouraging. We have noted that in those cases in which supportive medical measures are instituted along with frequent bronchoscopic drainages the patient has felt generally much better, and we believe that we have more encouraging palliative results.

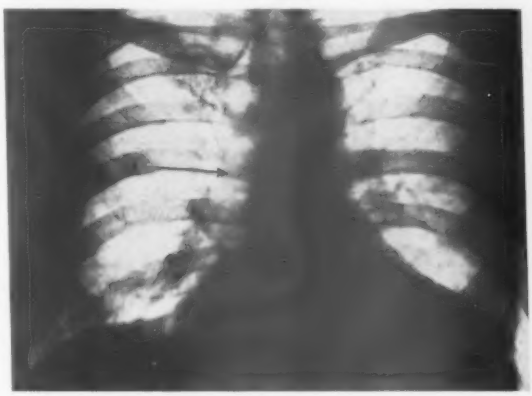

Fig. 7. After removal of bronchoscope, the radon tube is still in position at A.

Recently, with the aid of Dr. Jackson and Dr. Tucker we have felt justified in attempting to implant weak radon tubes directly into the growth. The growths in which we would advise this type of therapy are those that are bronchogenic in origin, preferably pedunculated, and those that have not invaded the bronchial wall to a great extent.

The radon tubes used for this treatment are weak, preferably not over 1.5 mc. in strength.

TECHNIQUE OF IMPLANTATION

Jackson and Pancoast developed a radon implanter which was used in the first two cases. This was modified by Tucker by adding an adjustable collar at the tip to control the depth of implantation, as illustrated in Figure 8.

The first two cases were implanted under bronchoscopic vision, and films were made directly afterward to see if the radon tubes remained in situ. This is extremely important as it is the only control showing whether the growth is receiving the planned irradiation.

In Case III, the growth was so friable it was almost impossible to control the position of the radon implant; in fact, it was necessary after the first attempt at implantation, to remove the dislodged radon tube from the lower portion of the right lower lobe by the bronchoscope with the bronchial or esophageal lumen. With the distally lighted tube the involved area in the bronchus or esophagus can be determined accurately, the location of the lesion diagrammed, and the implantation made at the most favorable point for irradiation as advised by the roentgenolo-

FIG. 8. Radon implanter, showing adjustable collar at tip to control depth of implantation.

aid of the biplane roentgenoscope. In reimplanting the radon, we used the improved radon implanter and the roentgenoscope as an aid to direct vision. We found that the procedure was more simple, with absolute control during the entire procedure. Since that time, roentgenoscopic aid during radon implantation through the bronchoscope has been a routine procedure. We have never had the slightest difficulty, and we are convinced that our results will improve in cases similar to the ones reported above.

SUMMARY

Two cases of carcinoma of the lung and one case of carcinoma of the esophagus are reported in which a method of direct radium treatment is suggested.

The types of growth amenable to this treatment are enumerated.

The technique of the treatment is described.

COMMENTS ON ENDOSCOPIC RADON IMPLANTATION

By GABRIEL TUCKER, M. D.

Bronchoscopic and esophagoscopic implantation of radon is mechanically feasible where the growth protrudes into the gist. An adjustable collar on the radon implanter controls the depth of implantation (Fig. 8). Roentgenoscopic check-up at the time of implantation should always be available. In one instance, where the growth in the bronchus was pedunculated, the radon passed through the mass and did not remain in the position where it was implanted. It was easily and quickly removed, however, by the use of an open-end aspirating tube under double-plane roentgenoscopic guidance. This occurred before the adjustable collar was used on the implanter, and there has been no further difficulty in four subsequent implantations on the same patient with the modified instrument. Threads may be attached to the radon tubes so that they can be subsequently removed, as advised by Dr. Sidney Yankauer. This can be done through the bronchoscope; the threads will, however, facilitate the coughing out of the radon seed after it has become inactive. In the esophagus this precaution would not be necessary. Very careful examination, by direct vision, of the region in which the implantation is made, will prevent puncture of blood vessels. Marked pulsation, expansile in character, is a contraindication to endoscopic implantation.

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MENSURATION OF THE HEART AND CHEST IN THE LEFT POSTEROANTERIOR OBLIQUE POSITION A COMPARATIVE STUDY

II. DETERMINATION OF TYPE OF CARDIAC ENLARGEMENT (RIGHT OR LEFT)*

By WALTER W. FRAY, M.D.
ROCHESTER, NEW YORK

IN A PREVIOUS communication[3] a method was presented which permitted the recognition of cardiac enlargement in the left oblique film. Comparative mensuration of the transverse diameter of the heart and the thorax in this position was successful in separating the enlarged hearts from the normal hearts in most instances in a group of 75 cases, the results being judged by actual autopsy findings in all cases of abnormal hearts.

While this method assists one in identifying the enlarged heart, it obviously gives no clue concerning the side of the heart affected. This is an end highly desired in cardiac roentgenology, and since our method of examination is based on proper placing of the patient so that the interventricular septum is at a right angle (or nearly so) to the film, an attempt was made to place the interventricular septum on the film using chest landmarks as a guide.

METHOD

A method of locating the septum between the ventricles has been described from this clinic by O'Kane, Andrew, and Warren[4] which is based upon the successful outlining of the pulmonary artery and proximal aorta. Since in many films this is difficult to accomplish due to the presence of pulmonary edema, blood vessel motion, or lack of definition from other causes, its use for routine purposes is curtailed. The present method being based on readily identified landmarks of the chest cage does not suffer this handicap.

An analysis of the projected points of the cross section of the chest at the cardiac level, rotated 45° to the base line (Fig. 1) gave us useful landmarks. It will be observed that in this position the interventricular septum falls midway between the projected right anterior axillary wall and the left costovertebral articulations. The approximate position of this septum can therefore be interpolated without difficulty on the left oblique film, if the film has been taken at the correct angle.

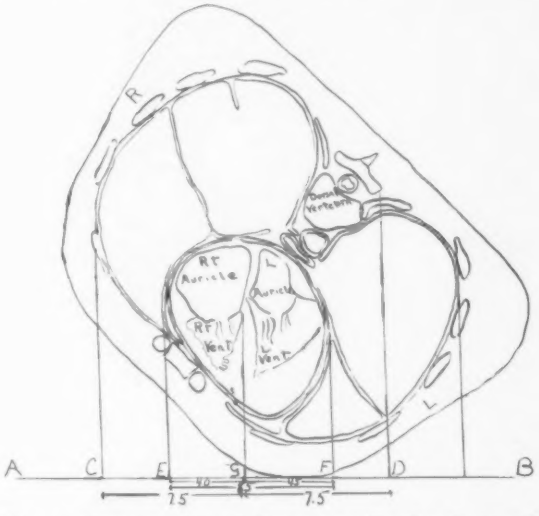


FIG. 1. Cross section of chest at cardiac level rotated 45° to base line. Note that the interventricular septum when projected is equidistant from the projected right axillary margin, and the left costovertebral articulations. (Adapted from Eycleshymer and Schoemaker.)

Similiarly, when such a left oblique film has been obtained it is found that a line (representing the plane of the interventricular septum) can be drawn through the normal heart in most cases, which divides it into two nearly equal portions. A line,

* From the Division of Radiology of the Department of Medicine, the University of Rochester, School of Medicine and Dentistry, and the Strong Memorial Hospital, Rochester, N. Y.

drawn from a point on the right lateral wall of the trachea immediately above the tracheal bifurcation down to a point midway between the right lower chest cage and left lower costovertebral articulations at the level of the cardiac ventricles, will divide the cardiac shadow in this manner. To compensate for errors arising due to variations in rotation and to some extent to variations in the chest shape, the following rule for the establishment of the lower point was used. The point *B* (Fig. 2) is laid off to the left of the trachea equal to that of *A* to the right. The distance *C*, which this projects to the left of the spine, is measured, and a point is taken at the lower ventricular level, which projects the same distance to the left of the spine. The lower portion of the interventricular septum will now be midway between this point *D* and the right lower chest wall *E* at this same level. A line can be drawn through the heart shadow representing this plane.

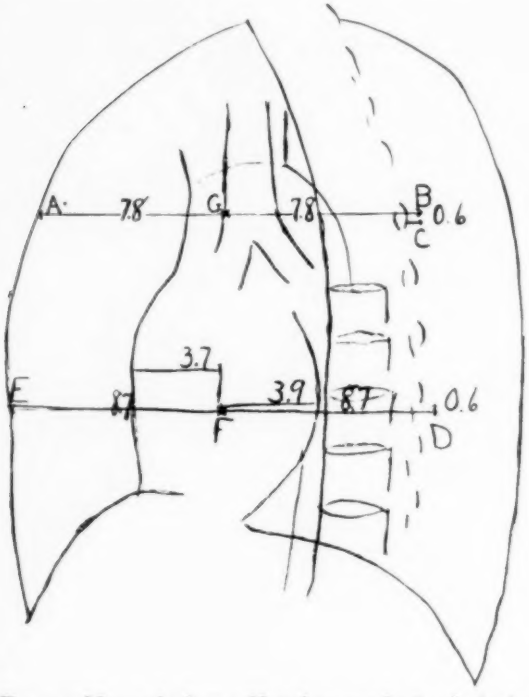


Fig. 2. Normal chest. Showing method of placing the interventricular septum. The distance (*AG*) (from right anterior chest wall to right wall of trachea immediately above its bifurcation) is measured. The point *B* is obtained by laying off the same distance to the opposite side of *G*. The amount (0.6 cm.) which this projects to the left of the spine is measured and this same distance, *D*, is laid off to the left of the spine at the level of the ventricles of the heart. The point, *F*, representing the plane of the interventricular septum will now be midway between this point, *D*, and the right lower anterior chest wall, *E*. This heart is normal and the septum is found to be centrally placed in reference to the cardiac shadow.

It is understood that, for a given individual, there can be only one oblique position in which the interventricular septum falls in exactly the same plane as the primary axis of the beam of radiation. Positions varying slightly from this will project the septum as a small band rather than a line. Our studies would indicate that in the latter case, this band is approximately bisected by the line and that satisfactory measurements of the diameters of the two sides of the heart can be made.

It should be stated that it was not possible to place this line in every case. It is useless to attempt it in cases in which the chest cage is deformed by old rickets, extensive fractures, and markedly scoliotic or kyphotic changes in the spine. The chest cage, even in normals, will vary considerably, but few cases were encountered in this series in which there was difficulty in placing the interventricular septum unless the thorax was obviously deformed or disproportioned.

Since the transverse diameter of the heart in the oblique view is approximately one-half of the diameter of the chest from the right lateral chest wall to the left costovertebral articulations, and the interventricular septum in normal cases roughly divides the cardiac shadow into equal right and left portions (ignoring the unequal thickness of the two ventricular walls), it becomes an easy matter to make an approximate estimate of the diameter of the individual ventricles, which would be normal for any particular case, by using the simple formula of $O.C.S./4$ (in which *O.C.S.* indicates the diameter of the chest as stated above). An estimate of the normal diameter was made in all cases of

TABLE I

NORMAL HEARTS

Comparison of Estimated Normal Diameters with Measurements Obtained from Left Oblique Film

Case	Age	Index of Rotation	Estimated Normal Diameter	Right Ventricle by X-Ray	Right Ventricle at Autopsy	Left Ventricle by X-Ray	Left Ventricle at Autopsy
H.S.	68		5.6	5.1	Brown atrophy No enlargement	5.3	Brown atrophy No enlargement
I.H.	59	2.0	5.5	5.4	No enlargement	5.3	No enlargement
L.H.	72	2.2	5.6	5.7	Brown atrophy No enlargement	5.8	Brown atrophy No enlargement
M.K.	54	2.2	5.4	5.7	No enlargement	5.5	No enlargement
E.P.	37	2.1	4.9	5.6	Very fatty heart	6.5	Extreme obesity
N.F.	43	2.0	5.9	5.6	No enlargement	7.0	No enlargement
I.F.	64	2.1	5.8	6.0	No enlargement	6.2	No enlargement
					Clinical Findings		*Clinical Findings*
D.M.	25	2.2	4.5	4.2	No cardiac disease	4.0	No evidence cardiac disease
N.S.	15	2.0	4.2	4.2	No cardiac disease	4.0	No evidence cardiac disease
I.W.	19	1.9	4.8	5.4	No cardiac disease	5.2	No evidence cardiac disease
E.B.	50	2.4	4.6	5.1	No cardiac disease	4.9	No evidence cardiac disease
D.C.	40	1.9	5.0	4.4	No cardiac disease	4.8	No evidence cardiac disease
F.G.	49	2.0	5.0	5.1	No cardiac disease	5.1	No evidence cardiac disease
R.C.	26	2.2	4.8	4.6	No cardiac disease	4.3	No evidence cardiac disease
L.M.	15	2.1	4.5	4.2	No cardiac disease	4.1	No evidence cardiac disease
V.W.	16	1.8	4.3	3.7	No cardiac disease	3.8	No evidence cardiac disease
L.W.	27	1.8	4.9	5.0	No cardiac disease	5.1	No evidence cardiac disease
P.A.	45	2.0	4.9	4.9	No cardiac disease	6.2	No evidence cardiac disease
A.P.	37	1.9	4.6	4.7	No cardiac disease	4.5	No evidence cardiac disease
C.M.	24	1.9	4.6	4.5	No cardiac disease	4.4	No evidence cardiac disease
L.B.	16	2.2	4.9	4.5	No cardiac disease	4.3	No evidence cardiac disease
R.B.	53	1.9	5.3	5.3	No cardiac disease	5.8	No evidence cardiac disease
M.H.	48	2.0	4.6	4.9	No cardiac disease	5.3	No evidence cardiac disease
A.C.	20	2.0	5.2	5.8	No cardiac disease	5.5	No evidence cardiac disease
I.L.	29	1.9	4.6	5.0	No cardiac disease	5.1	No evidence cardiac disease
M.W.	8	1.8	3.8	3.3	No cardiac disease	3.6	No evidence cardiac disease
M.S.	22	2.2	4.4	4.5	No cardiac disease	4.5	No evidence cardiac disease
E.H.	39	1.8	5.0	5.3	No cardiac disease	4.8	No evidence cardiac disease
C.T.	17	2.1	5.1	4.7	No cardiac disease	4.8	No evidence cardiac disease
S.M.	40	1.8	4.6	4.8	No cardiac disease	4.5	No evidence cardiac disease
E.B.	34	2.0	5.0	4.8	No cardiac disease	4.5	No evidence cardiac disease
G.F.	56	1.9	5.1	5.6	No cardiac disease	5.4	No evidence cardiac disease
F.R.	43	2.1	5.1	5.1	No cardiac disease	5.0	No evidence cardiac disease
I.H.	23	2.0	4.6	4.1	No cardiac disease	4.6	No evidence cardiac disease
M.L.	22	1.9	4.4	3.8	No cardiac disease	4.8	No evidence cardiac disease
L.H.	44	2.1	4.4	4.3	No cardiac disease	4.6	No evidence cardiac disease
P.B.	38	2.2	4.8	3.8	No cardiac disease	4.9	No evidence cardiac disease
M.H.	16	1.9	4.3	4.2	No cardiac disease	4.6	No evidence cardiac disease
M.J.	24	2.2	4.2	3.9	No cardiac disease	3.9	No evidence cardiac disease
R.T.	22	1.7	4.6	4.4	No cardiac disease	4.4	No evidence cardiac disease
A.M.	11	1.7	4.1	3.6	No cardiac disease	3.8	No evidence cardiac disease
B.G.	54	2.2	5.2	4.4	No cardiac disease	4.6	No evidence cardiac disease
Total 42				Av. variation from estimated normal 0.3		Av. variation from estimated normal 0.4	

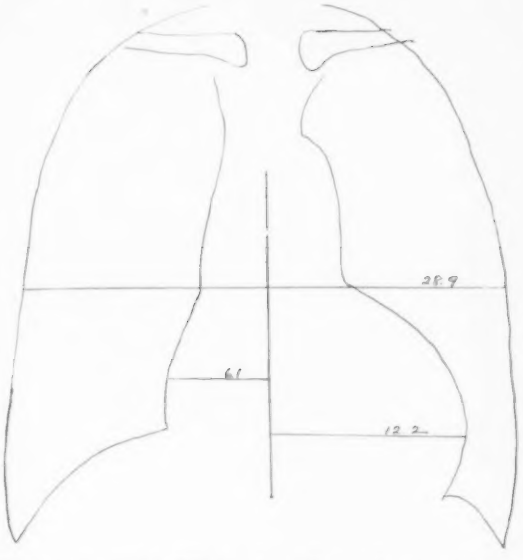
normal and enlarged hearts in this series using this formula. The estimated normal diameter of each ventricle was then compared with that obtained after determining the position of the interventricular septum by the method previously described. In cases where this line representing the interventricular septum could be erected, it became an easy matter to detect either right or left ventricular enlargement or both, since the normal diameter for any particular individual can be estimated by dividing the transverse diameter of the chest (from the right lateral chest wall to the left costovertebral articulations) by 4. Because we are working with a series of cases where we can be quite certain of the presence or absence of cardiac enlargement in every case and also certain of the type of enlargement present (right or left) and of its extent, the comparison of the estimated ventricular diameter with conditions actually found at autopsy (in all cases where any enlargement was present) furnishes an excellent check on the correct placing of the interventricular septum. This comparison was made in all the enlarged hearts found post mortem and was also made in the clinical series where no suspicion of cardiac disease was present.

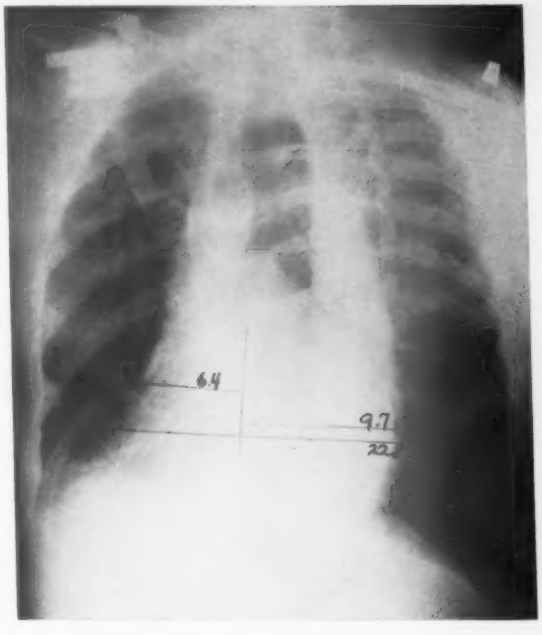
TABLE II

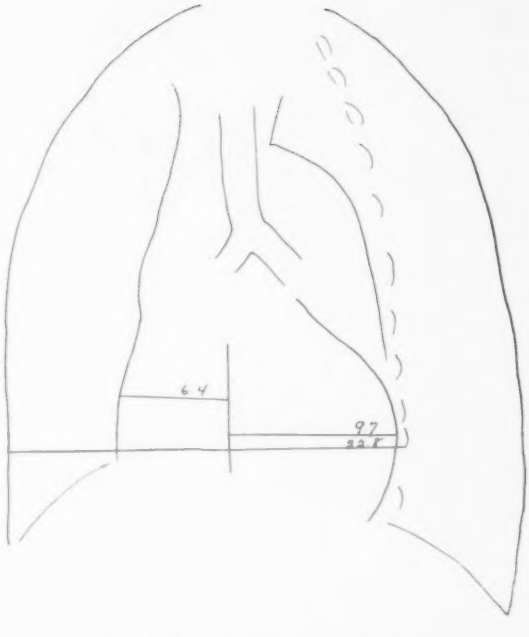
PATHOLOGICAL HEARTS; BILATERAL ENLARGEMENT

Comparison of Estimated Normal Diameters with Measurements Obtained from Left Oblique Film with Check Findings at Autopsy

Case	Age	Index of Rotation	Estimated Normal Diameter	Right Ventricle by X-Ray	Right Ventricle at Autopsy	Left Ventricle by X-Ray	Left Ventricle at Autopsy
G.H.	50	2.0	5.1	7.4	Pronounced enlargement	8.1	Extensive enlargement
S.M.	15	2.0	4.9	5.5	Slight enlargement	6.4	Pronounced enlargement
B.D.	20	1.5	4.1	5.2	Very slight enlargement	6.4	Slight enlargement
A.V.	57	2.3	4.9	7.9	Moderate enlargement	7.6	Pronounced enlargement
F.V.	69	1.8	5.6	6.4	Moderate enlargement	9.7	Pronounced enlargement
C.D.	51	1.7	5.6	5.8	Slight enlargement	7.7	Slight enlargement
S.H.	65	2.3	6.0	7.5	Moderate enlargement	9.3	Extreme enlargement
F.O.	46	1.9	6.1	7.4	Slight enlargement	8.4	Pronounced enlargement
I.S.	37	2.2	5.2	5.9	Moderate enlargement	8.6	Extreme enlargement
J.S.	72	1.8	4.9	6.1	Slight enlargement	7.6	Slight enlargement
F.S.	43	2.1	5.3	6.8	Slight enlargement	7.8	Slight enlargement
C.D. ++	71	2.3	5.8	7.3	Moderate enlargement	7.7	Pronounced enlargement
J.P.	42	2.5	5.6	7.3	Slight enlargement	8.7	Moderate dilatation
H.B.	60	1.7	5.1	6.6	Slight enlargement	9.9	Pronounced enlargement
J.S.	41	2.2	5.6	8.8	Pronounced enlargement	9.0	Extreme enlargement
G.K.	65	2.2	5.4	6.7	Slight enlargement	8.0	Pronounced enlargement
C.S.	63	2.1	5.4	7.3	Slight enlargement	7.0	Pronounced enlargement
E.C.	50		5.3	7.0	Moderate enlargement	7.3	Pronounced enlargement
S.B.	7	1.7	4.0	4.3	Slight enlargement	4.2	Slight enlargement L > R
+++ T.P.	49	2.5	5.7	6.7	Moderate enlargement	7.7	Pronounced enlargement L > R
L.J.	4	2.2	3.5	5.3	Slight enlargement	4.2	Moderate enlargement
R.B.	59	1.7	5.5	7.7	Pronounced enlargement	10.8	Pronounced enlargement
E.H.	76	2.1	4.8	6.5	Moderate enlargement	7.1	Pronounced enlargement
Total 23			Av. variation from estimated normal 1.4			Av. variation from estimated normal 2.6	







FIGS. 3, 4, and 5. Bilateral cardiac enlargement, particularly marked on the left side, in a man aged sixty-nine, with arteriosclerotic heart disease. Marked enlargement is indicated by the low oblique cardiothoracic index (1.4). On placing the interventricular septum, the enlargement is noted to affect the left side chiefly, though slight enlargement of the right is suggested by the measurements: Right ventricle, 6.4 cm.; left ventricle, 9.7 cm.; estimated normal, 5.6 cm. These findings were verified at autopsy, and in addition a large mural thrombus and an old large infarct of the left ventricle was found. The heart weight was 660 grams.

A total of 73 cases were studied in this manner. There were 23 cases of bilateral cardiac enlargement and 8 cases of unilateral cardiac enlargement, all proved by autopsy findings. The normal series consisted of 35 clinical cases, in which there was no suspicion of cardiac disease, and 7 autopsy cases. The series was approximately equally divided between the two sexes. The ages varied in the normal series from eight to seventy-two years, and in the series of enlarged hearts from four to seventy-six years.

RESULTS

Normal Series. The findings in the normal series are listed in Table 1. It will be noted that there is very close agreement between the ventricular diameters obtained after the erection of the interventricular septum and the estimated normal throughout the series of 42 cases. The average deviation from the estimated right ventricular diameter for the normal series was 3 mm. which appears remarkably close. The greatest single variation was 1 cm. Comparing the measurements of the left ventricle in the same way an average deviation of 4 mm. was obtained with the great-

est individual variation of 1.6 cm. (in a very obese heart).

The left anterior oblique film of a youthful individual with a normal heart is illustrated in Figure 2. This patient gave no history or physical signs relating to cardiovascular disease. The film reveals a heart of normal size with a transverse diameter of 7.6 cm. and a normal oblique cardiothoracic index of 2.3. The line indicating the interventricular septum divides the heart in the oblique view into two nearly equal parts. The diameter of the right ventricle measures 3.7 cm., while the left is 3.9 cm. Both of these measurements are less than 1/4 the transverse diameter of the chest from the right anterior axillary region to the left costovertebral articulations (1/4 of 17.4 cm. = 4.3 cm.). Figures 2, 3, and 4 in the first paper[3] of this series likewise illustrate the heart of an individual which showed no dilatation or hypertrophy at autopsy. The diameter of the right ventricle measured 5.4 cm. and the left 5.3 cm., while the estimated normal was 5.5 cm. (1/4 of 22.2 = 5.5).

Enlarged Hearts. The contrast in the series of enlarged hearts is striking. Here the measurements of the ventricular diameters exceeded the estimated normal and usually the measurement reflected the degree of the enlargement. Hearts showing bilateral enlargement illustrate the point well.

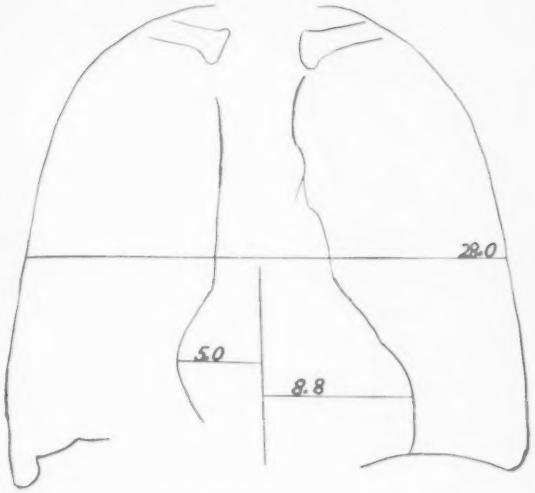
Table II lists all these cases with the findings at autopsy. In this series the measured right ventricular diameter exceeded the estimated normal in all cases (average for series 1.4 cm.). In most cases, it exceeded 1 cm., though in a few cases the amount was slight and would be insufficient for clinical significance. The transverse diameter of the left ventricle likewise exceeded the estimated normal (average for

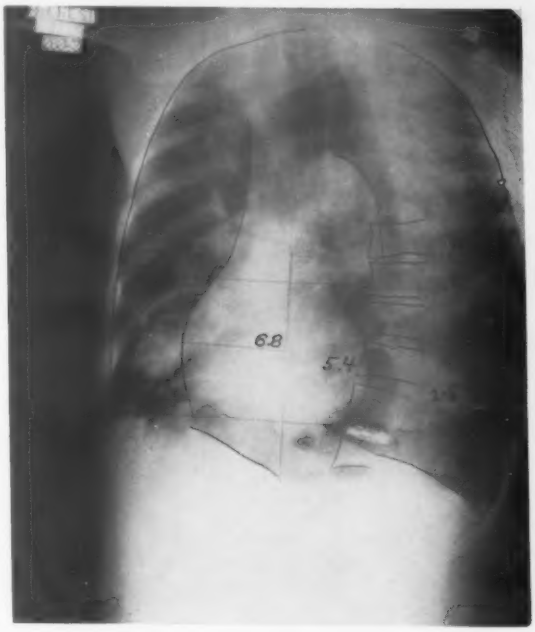
TABLE III

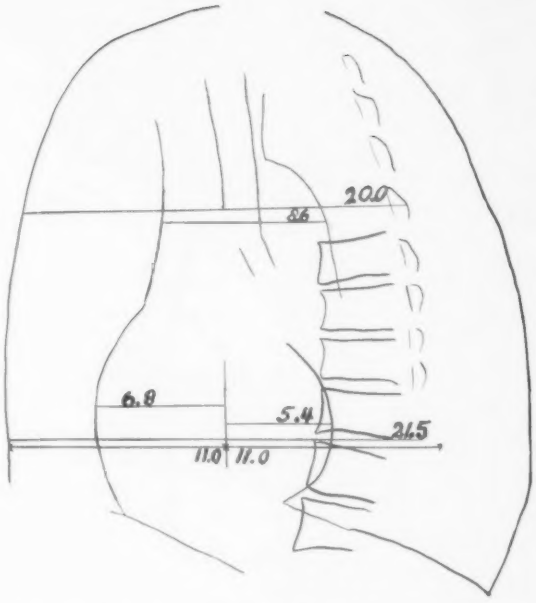
PATHOLOGICAL HEARTS; UNILATERAL ENLARGEMENT

Comparison of Estimated Normal Diameters with Measurements Obtained from Oblique Film and with Check Findings at Autopsy

Case	Age	Index of Rotation	Estimated Normal Diameter	Right Ventricle by X-Ray	Right Ventricle at Autopsy	Left Ventricle by X-Ray	Left Ventricle at Autopsy
				Right Heart Enlargement			
H.R.	11		4.4	5.9	Moderate enlargement	3.9	Normal
J.H.	45	1.8	5.4	6.8	Pronounced enlargement	5.4	Normal
M.J.	43	1.6	4.6	4.8	Slight enlargement	5.3	Normal
			Av. variation from estimated normal 1.0			Av. variation from estimated normal 0.4	
				Left Heart Enlargement			
C.H.	60	2.0	5.9	5.8	Normal	7.9	Moderate enlargement
C.M.	57	2.5	5.3	5.6	Rt. auricular dilatation	6.7	Pronounced enlargement
C.B.	50		6.6	6.9	Normal	8.8	Pronounced enlargement
E. S.	61	2.3	5.6	5.3	Normal	5.9	Slight enlargement
G.G.	73	1.6	5.3	4.9	Normal	6.5	Slight enlargement
			Av. variation from estimated normal 0.3			Av. variation from estimated normal 1.4	



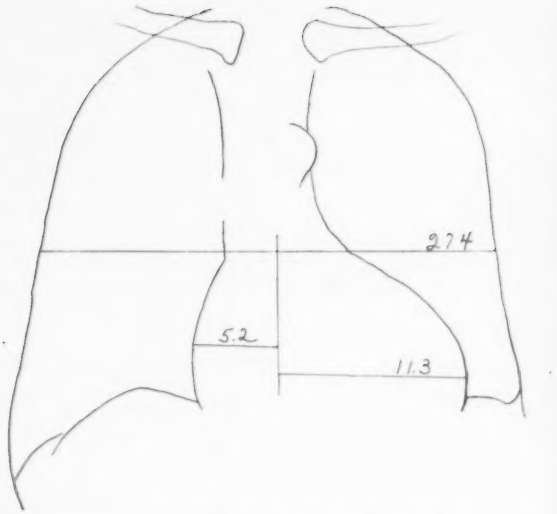


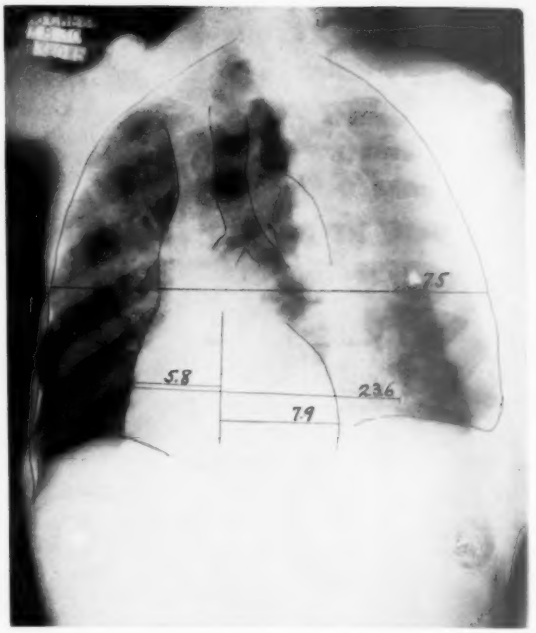


Figs. 6, 7, and 8. Unilateral cardiac enlargement (right) in a patient dying of right heart failure. The cardio-thoracic ratio of the posteroanterior film is normal (2.0) while the ratio obtained from the left oblique film would indicate probable enlargement (1.8). On placing the interventricular septum a definite enlargement is found to affect the right heart (right ventricle 6.8 cm.; estimated normal 5.4 cm.) while the measurement of the left heart is within normal limits. Autopsy verified these findings. The failure of the right side of the heart was found to be secondary to chronic fibrotic pulmonary disease with pneumoconiosis. The heart weight was 450 grams.

series 2.6 cm.). Only 2 of the cases showed a diameter which did not exceed the estimated normal by more than 1 cm.

The left oblique film and tracings of a case of bilateral cardiac enlargement are reproduced in Figures 3, 4, and 5. This patient, sixty-nine years of age, gave a history of dyspnea for fifteen years which was never marked until the last three or four months of his life. Two days before his death he was seized with sudden abdominal pain about the umbilical region due to a thrombosis of the superior mesenteric artery. The main clinical diagnoses were arteriosclerotic heart disease and mesenteric thrombosis. His blood pressure was 114/78. Both the posteroanterior and left oblique films taken prior to the arterial occlusion showed an obvious cardiac enlargement with a low oblique cardiothoracic index (1.4). After erecting the interventricular septum on the left oblique film, it became apparent that this enlargement affected both the right and left sides of the heart, as indicated by the measured diameters of the right (6.4 cm.) and left (9.7 cm.) ventricles, exceeding the estimated normal (5.6 cm.). The more marked enlargement, it should be noted, is on the left side. At autopsy the right ventricle was only slightly hypertrophied, while the left

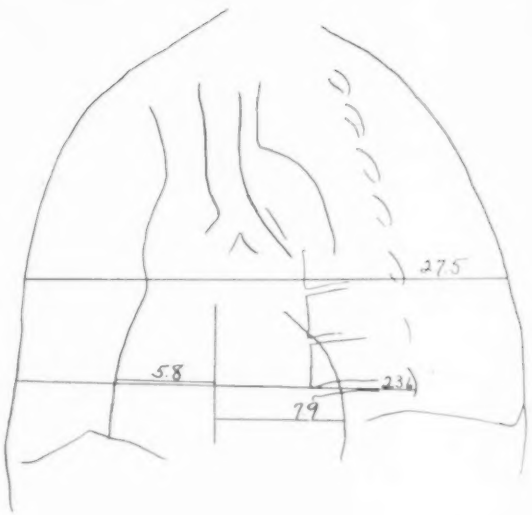




Figs. 9, 10, and 11. Unilateral cardiac enlargement with hypertrophy of left ventricle. This patient, a male aged sixty, died as a result of a hypernephroma of the left kidney. The heart, though enlarged, played no part in his death (oblique cardio-thoracic index of 1.7). The placing of the interventricular septum demonstrates the presence of a left-sided enlargement only (right ventricle 5.8 cm.; left ventricle 7.9 cm.; estimated normal 5.9 cm.). At autopsy the chambers of the heart were all of normal size except the left ventricle which showed definite though not marked hypertrophy. Heart weight was 370 grams.

ventricle was greatly enlarged due to both hypertrophy and dilatation. The heart weighed 660 grams. A large mural thrombus of the heart was found, together with an old, large infarct of the left ventricle. Other findings relating to the cardiovascular system were organizing infarcts of the left kidney, a moderate generalized arteriosclerosis, and evidence of chronic passive congestion.

Cases with unilateral cardiac enlargement (Table III) showed comparable changes. In 3 cases with enlargement of the right heart, the measured diameter of the right ventricle exceeded the estimated normal by 1.0 cm. (average). In one case, however, the amount was only 0.2 cm. and this is insufficient to possess significance. In the other two cases a definite enlargement was evident. In all three of these cases the left ventricle appeared to be within normal limits.



One of the cases of cardiac enlargement affecting the right side only is illustrated by a left oblique film and tracings in Figures 6, 7, and 8. This patient died a typical death due to right heart failure. This was secondary to chronic fibrotic pulmonary disease with pneumoconiosis. The tracing of the posteroanterior film fails to detect evidence of cardiac enlargement. The left oblique outline showed an enlarged heart with a heart-chest index of 1.8. On placing the interventricular septum, it became ap-

TABLE IV

SHOWING DEGREE OF VARIATION BETWEEN MEASURED AND ESTIMATED VENTRICULAR DIAMETERS

	No. of Cases	Right		Left	
		Average Variation	Maximum Variation	Average Variation	Maximum Variation
Normal	42	0.3	1.0	0.4	1.6
Bilateral cardiac enlargement	23	1.4	3.2	2.6	5.3
Unilateral enlargement (right)	3	1.0	1.5	0.4	0.7
Unilateral enlargement (left)	5	0.3	0.4	1.4	2.2

parent that this enlargement affected only the right heart. The right ventricular diameter measured 6.8 cm., while the estimated normal was only 5.4 cm. At autopsy, the right auricle was greatly dilated while the right ventricle showed evidence of marked enlargement with dilatation and hypertrophy. The right ventricle formed the apex of the heart. The heart weight was 450 grams.

Similiarly, the left ventricle in cases with enlargement of the left heart appeared enlarged (average 1.4 cm.) in 4 out of 5 cases, while the diameter of the right ventricle appeared normal in all this series.

Figures 9, 10, and 11 illustrate a typical case of left ventricular enlargement. This individual, aged sixty years, died following an operation for a hypernephroma of the left kidney, which had invaded the renal, iliac, and lumbar veins extensively, with dissemination of widespread metastases. Cardiac symptoms had been present only during the last three months of his life, and related chiefly to dyspnea and during the last month to some edema of the ankles. Clinically this was believed to be due to arteriosclerotic heart disease. The blood pressure was 130/65. His films showed evidence of some cardiac hypertrophy (oblique cardiothoracic index of 1.7). When the interventricular system was erected, there was evidence of a left ventricular hypertrophy only. The estimated normal ventricular diameter of this individual is 5.9 cm. His right ventricle measured 5.8 cm. and his left 7.9 cm. These findings were substantiated at autopsy. There was some left ventricular hypertrophy with the other chambers of the heart within normal limits. The coronaries were slightly sclerosed. The valves were not abnormal, except for slight thickening at the mitral and aortic. The aorta showed a moderate degree of arteriosclerosis. The heart weighed 370 grams.

In the first paper[3] of this series Figures 8, 9, and 10 illustrate a case of slight left ventricular hypertrophy which was readily demonstrated by the left oblique film but which would be missed in the postero-anterior view if the conventional cardiothoracic index is accepted as the criterion. The measurements of the left oblique view suggest an enlarged heart with the enlargement affecting the left ventricle only. The measured diameter is 6.5 cm. while the estimated normal is 5.3 cm. A slight but definite hypertrophy of the left ventricle was found at autopsy.

The average and maximum enlargement as indicated by comparing the measured with the estimated diameters in cases of unilateral and bilateral cardiac enlargement are contrasted with the normal series in Table IV. Thus in normal hearts, the variation is almost always less than 1 cm. In hypertrophied hearts, measurements indicate that the transverse diameter exceeded the estimated normal for a given chest size by 1 cm. or over in most cases.

SUMMARY

A method for determining the approximate position of the interventricular septum in respect to the cardiac shadow of the left oblique film has been described. The transverse diameter of both ventricles may be measured after the erection of this

septum. The normal transverse diameter of each ventricle may be estimated by dividing the transverse diameter of the left oblique chest from the right axillary region to the left costovertebral articulations by four. A comparison of the measured and estimated normal ventricular diameters of the same individual permits the recognition of a left or right ventricular enlargement in cases of either unilateral or bilateral cardiac enlargement.

The results of this method have been tested in a series of 73 cases, in which the cardiac pathology has been checked by autopsy findings. In the normal group only 3 cases showed the measured ventricular diameter exceeding the estimated normal by more than 1 cm. (which probably represents the maximum range to be allowed for normal variation). In cases of bilateral cardiac enlargement, the measured diameter invariably exceeded the estimated normal, but in 6 cases the amount was less than 1 cm. and in 3 of these no significance could be attached to the measurements. The cases of unilateral cardiac enlargement were correctly recognized by this method, except in 2 instances in which the measured diameter exceeded the estimated normal by only a few millimeters. Hence, out of 73 cases the diagnosis of right or left cardiac hypertrophy has been correctly made in 62.

CONCLUSIONS

1. Readily identified landmarks of the thorax permit the approximate localization of the interventricular septum on the left oblique film in most cases.

2. The establishment of this septum permits the recognition of enlargement of either the right or left side of the heart.

3. Working with known material, this method has been successful in determining the presence or absence of either left or right cardiac enlargement in over three-fourths of a small series of 73 cases.

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THE ROENTGENOLOGIC ASPECT OF SUBACUTE AND CHRONIC INTESTINAL INTUSSUSCEPTION*

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IT IS A well-known fact that roentgen examination offers considerable information of value to the surgeon in cases of acute intussusception in infancy, both as to the type and site of the obstruction. In fact, the reduction of such invaginations has been recorded during these examinations, a result which may not always be desired.[13] Subacute and chronic intussusception in adults and children is also a well-known surgical condition; 300 cases, for example, were reported by Eliot and Corscaden.[8] But that the latter condition has characteristic roentgenologic manifestations, easily demonstrable, often pathognomonic, is not, if one may judge by the literature, common knowledge. It is possible, of course, that most cases are too ill to be subjected to any procedure but immediate surgery, though that is not our experience. On the other hand, the surgeon is often fearful that the barium used may induce a complete block or provide a poor surgical field for his subsequent operation. Whatever the reason, although the roentgenologic discussions of this condition in the literature are unusually good, they are sparse. Textbooks, particularly, lack the available information. The fact that we are able to report 5 cases observed during two years at this Hospital shows the condition to be not at all rare and shows further the value of complete roentgen examination in all cases of intestinal obstruction.

An intussusception may start in any portion of the colon, but in the large majority of cases it is the upper portion which is invaginated into the lower. Mummery[12] states that this is always the case, further adding that retrograde intussusceptions do occur but only before death or during asphyxia. This statement is not borne out, as will be apparent from Case III reported below. Usually the intussusception increases in length at the expense of the ensheathing layer. The apex always remains the same and as it is pushed forward by peristalsis, more and more of the sheath is drawn in to allow of its progression. The only exception is in the ileocolic type, the ileum prolapsing through the ileocecal valve, where more and more of the ileum prolapses and the apex therefore changes. As the intussusception grows, the mesentery is dragged in between entering and returning layers; as a result, the tumor becomes curved from the tension of the mesentery, the latter sooner or later becoming strangulated.

The etiology of intussusception is still somewhat obscure. Two things are apparently necessary for its causation, a narrowing of the bowel, anatomic or physiologic, and a disturbance of normal peristaltic movements. In 123 cases reported by Brocq and Gueullette,[4] the anatomic cause was tumor in 36 per cent. The tumor is more often benign, probably because this type is often movable and pedunculated. The latter are not indispensable features, as for example, the cases associated with submucous lipomas. With moderate frequency, however, malignant tumors, and benign tumors that have secondarily degenerated, are found. Among inflammatory causes, tuberculosis is the most prominent though various other conditions have been noted, as for example, a Meckel's diverticulum or pericolic membranes. Appendicitis as an etiologic factor has not yet been proved; it is very difficult to determine whether the inflammation of the appendix that is noted preceded or is the result of the intussusception. Trauma has been reported; many "physiologic" factors have been blamed, as for example, fright, very

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cold or rough diet. In this French series the authors note that a definite cause could not be found in about 50 per cent of the cases.

The important theories that have been offered to explain intussusception are as follows:

1. Normal antiperistalsis in the cecum and ascendans must be a factor in the production of the tumor, but there is an additional factor as shown by the experiments of Mummery which demonstrate that in normal bowel wall an intussusception tends to reduce itself and not to be progressive, even when violent contractions occur (see also the work of Dieterichs[7]).

2. If a polyp is the starting point of an invagination, it acts as a foreign body and stimulates the bowel to pass it on. Being attached to the bowel wall by a pedicle, it pulls this in after it and as the polyp is pulled farther into the bowel, the bowel wall goes along with it, producing the intussusception.

3. Ileocecal intussusception in children has been explained by assuming a preexisting prolapse of the ileum comparable to prolapse of the rectum (Barnard[3]). This, however, is not confirmed by clinical findings.

4. Another explanation is to assume the ileocecal valve plugged by an indigestible bolus acting as a foreign body. This is the view held by Perrin and Lindsay,[14] who conclude that the condition is started by the production of a foreign body, by polyp, or by swelling of the patches of lymphoid tissue in the bowel wall. As a predisposing factor is mentioned narrowness of the colon in early life.

5. A relaxed or paralyzed condition of the bowel is also mentioned as a possibility (Lichtenstein).[10]

The symptoms are those of acute, subacute or chronic intestinal obstruction, naturally varying so greatly in different patients that a characteristic syndrome cannot be described. Usually, the diagnosis of obstruction is the only one possible clinically. Only in the presence of a movable variable tumor mass does the diagnosis definitely suggest itself. The picture is further complicated when adhesions form at the apex of the intussusception, the tumor can no longer be reduced and strangulation of the mesentery occurs.

The roentgen appearance of intussusception has been dealt with sporadically in the literature, probably the reason for the little space devoted to it in the textbooks. Thus Carman[5] states that only two cases had been reported roentgenologically at the time of his last edition, those of Lehmann[9] and Groedel. Schlesinger-Rachwalsky[15] states the diagnosis to be difficult; often, it is said, there are only negative findings, or there is lengthening or a change in size of the small bowel lumen in the region of the cecum; a definite diagnosis is only possible when the typical picture described by Lehmann is seen. A more complete description of reported cases is given by Assmann.[2] The first important article in English on the subject is that by Ashbury,[1] who reported a case fully and offered a complete bibliography of the general subject. In his case, at the twenty-four hour examination, "what was thought to be the cecum was situated high on the right side and gave the impression of not having descended in development to the right iliac fossa. The hepatic flexure and transverse colon had an unusually broad lumen and presented a broad central filling defect extending across to the splenic flexure where there was practically no barium. . . . The barium enema flowed freely and filled the colon rapidly; the filling defect in the transverse portion had disappeared (which is explained by a partial release of the invaginated intestine) and the lumen of the colon was narrower. As the enema reached the ascending colon, it rounded out into what was thought to be the cecum. The caput showed a concavity continuous with a filling defect in the cecum about the size of an egg." In Figure 1, the roentgenograms of Ashbury's case are reproduced in silhouette. His case was due to lymphosarcoma.

In 1918, Walls[16] described what one might call the general roentgen appearance

of the condition as follows: "The barium enema fills the bowel until arrested by the intussusception and a small amount of barium would pass for a longer or shorter distance between the intussusceptum and intussuscipiens. The shadow made by the thin layer would be so appreciably different from that made by the dense barium that the end of the column would appear to be concave or U-shaped. Such an observation would not occur in any other condition of the bowel . . . ." This description, while fundamental, does not explain entirely the apparently bizarre pictures that are seen. Recourse must be had to a consideration of the morphological appearance of the various types of intussusception in their various stages. In Figure 2 are reproduced diagrams from the surgical article of Brocq and Gueullette. They do not need comment but their study is suggested, for they offer the key to the interpretation of the roentgenograms.

Fig. 1. Diagrams of roentgenograms of Ashbury's case.

Very excellent reviews and original contributions have appeared recently in the Italian literature; in fact, little can be added to the articles of Meda[11] and Castronovo.[6] The latter makes his examination by means of an opaque meal, barium enema, and air insufflation, if necessary, insisting on roentgenoscopic control. He divides the diagnostic signs of ileocecal invagination into two groups: the indirect signs and the generic signs of intestinal obstruction, absence of gas in the hepatic flexure, displacements of the stomach or duodenum, the tendency for loops of small bowel to occupy the place of the invaginated colon and their arrangement, the appearance of the terminal loop of ileum. The direct signs with a meal are that of a form of ileal stenosis characteristically appearing like the beak of a bird, absence of the ileocecal regions, and an opaque streak (Fig. 3). This author considers two types of intussusception, that having the form of a complete obstruction which he believes is always caused by tumor, and that with the form of a sheath. The latter takes on various shapes described as resembling a fork, pincers, onion, rosette, opaque cloak, that is, various degrees of impregnation of the sheath up to a complete hiatus. He believes these diverse pictures depend on the tone of the intussusceptum. The latter is also said to determine the amount of change the picture undergoes comparing the full and partially evacuated colon. Finally he calls attention to the spiral forms that are so typical.

In Figure 3 are seen reproductions of diagrams appearing in the article by Meda. They include sketches of all the reported cases of intussusception arranged in groups and offer a valuable diagnostic aid. It is particularly interesting to compare these figures with similar diagrammatic sketches made of the experimental results of Brocq

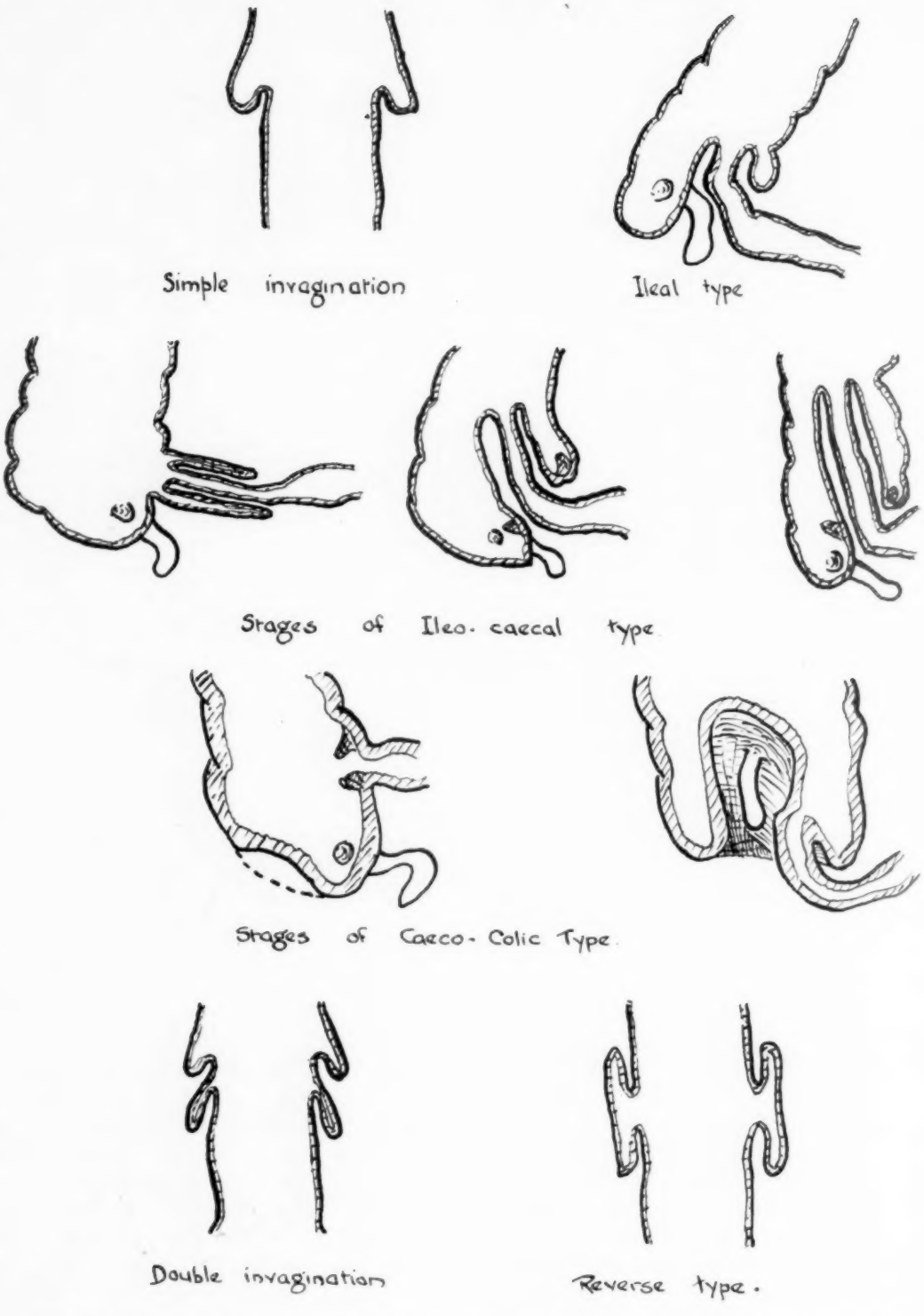

Fig. 2. Diagrams of the anatomical variations of colonic intussusception (Brocq and Gueullette).

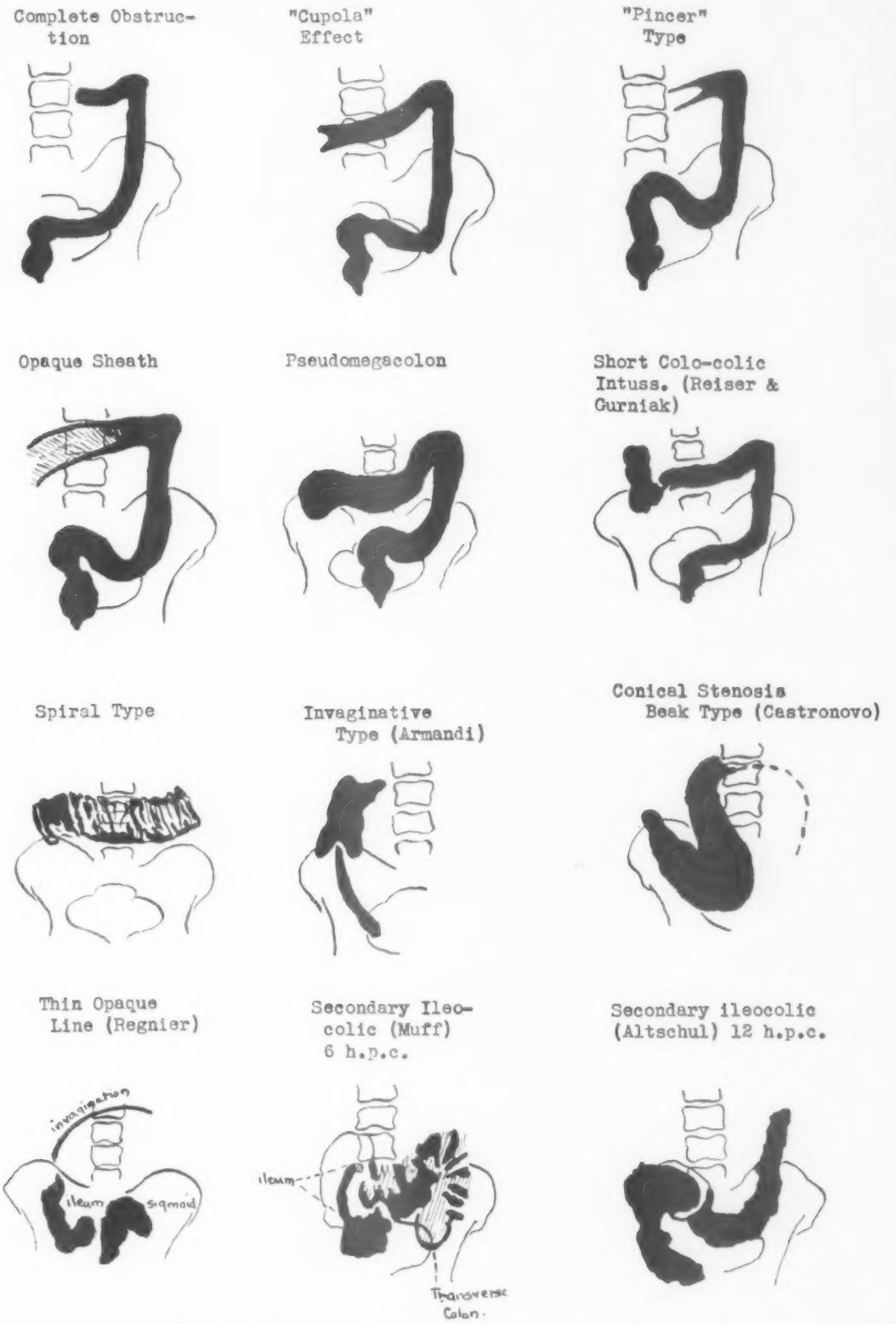

FIG. 3. Variations in the roentgen appearance (after Meda).

Fig. 4. Experimental intussusception (isolated loops filled with barium) (Brocq and Gueullette).

Fig. 5. Case 1. Barium enema. Intussusception with pedunculated lipoma of cecum.

Fig. 6. Case 1. After defecation.

and Gueullette. They produced artificial intussusception in the intestinal tract of dogs, and then filled these areas with barium. In Figure 4 diagrams of their photographs are reproduced from their article.

CASE REPORTS

Case I. P. B., male, married, aged twenty-eight; admitted June 9, 1930, with a six day history of colicky generalized abdominal pain with tarry stools. The day before admission, there had been a slight diarrhea and the stool had contained fresh blood. He had previously been constipated for years. He was a diabetic who one year before had been treated in this hospital for diabetic coma. On admission the abdomen was soft; a hard, tender, sausage-shaped mass extended down the right side of the abdomen. Temperature, 102° F. A diagnosis of intussusception was made and confirmed by roentgen examination (Dr. E. W. Benjamin) (Figs. 5 and 6). At operation an ileocecal intussusception was found and easily reduced.

Fig. 7. Case II. Barium enema. Case of multiple benign pedunculated adenomata of the sigmoid with intussusception.

Fig. 8. Case II. After defecation.

A mass was felt within the cecum which after cecotomy was excised and found to be a pedunculated lipoma. Patient died after going into collapse one day after operation. Pathological diagnosis—Fibrolipoma with purulent inflammation.

Case II. R. B., male, married, aged forty-four; admitted March 13, 1929, with a history of hemorrhoids for twenty-five years which bled occasionally. The morning of admission he passed 100 c.c. of bright red blood. This episode was repeated several times during the day. Physical examination was negative except for local condition. Some examiners described a large rectal tumor which others were unable to find; others described a large pedunculated tumor. Roentgen examination showed several filling defects in the sigmoid at levels different from those found at sigmoidoscopy. The conclusion was that there were multiple, benign, pedunculated adenomata, mobile in their own right and still more so because of a partial intussusception (Figs. 7 and 8). This was confirmed at operation.

Case III. S. B., female, married, aged fifty-four; admitted October 29, 1929, with a history of cramp-like pains in the right upper quadrant for four months with watery diarrhea. Umbilical hernia for fourteen years. Physical examination was negative, except for the hernia and a mass in the left upper quadrant thought to be left kidney. A barium enema showed complete

Fig. 9. Case III. Lipoma of transverse colon with retrograde intussusception.

Fig. 10. Case III. After defecation.

obstruction in the proximal part of the descending colon, at which point a large irregular, almost circular defect was seen occupying the entire transverse lumen of the colon (Figs. 9 and 10). At operation, in the left half of the transverse colon, a freely movable tumor was found attached near the mesenteric border by a pedicle. The tumor had moved from left to

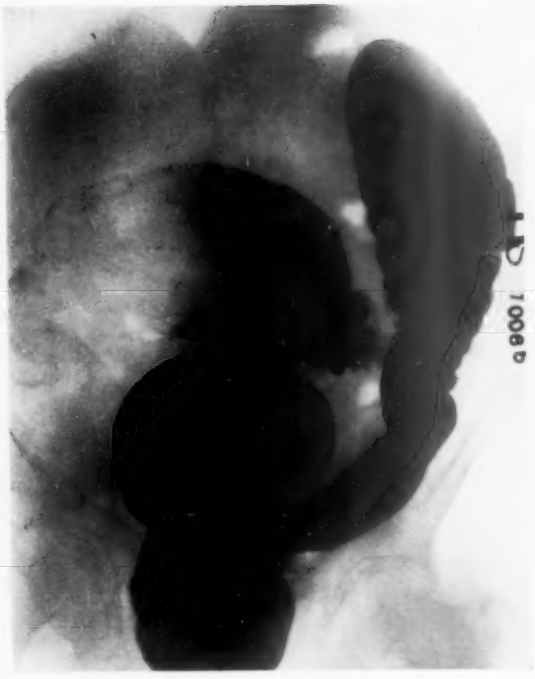

Fig. 11. Case IV. Barium enema in a cecal carcinoma with intussusception.

Fig. 12. Case IV. After defecation.

right causing an intussusception of half the intestinal wall for a distance of about 6 inches. Pathological report—Lipoma with ulceration of the lining mucosa.

Case IV. N. A., male, aged fifty-three; admitted August 8, 1930, with a history of sharp epigastric pains, frequent vomiting one hour after meals, loss of 24 lb., all symptoms of $4\frac{1}{2}$ months' duration. Patient showed a severe secondary anemia. There was a mass in the mid-abdominal region about the size of a grapefruit, soft, non-tender and freely movable. Barium enema showed a very large foreign body in the lumen of the transverse colon suggestive of a polypoid tumor (Figs. 11 and 12). Operation revealed a large intussusception of a cecal carcinoma into the transverse colon. Some of the terminal ileum was also intussuscepted.

Case V. Male, aged three, with a history of sudden onset of pain in the abdomen. Some vomiting day after onset. No real stools for a day and a half, but passage of flatus and some mucus. The abdomen had been rigid, but three days after the onset when examined by roentgen ray, it had become soft. History of swallowing lollipop stick day before onset. Roentgen examination was made first for foreign body. None was found. A barium enema showed a large defect involving the mesial half of the cecum about the ileocecal valve. A diagnosis of intussusception was made (Fig. 13). At operation the terminal ileum was found pulled through the ileocecal valve into the cecum and held there by several bands of adhesions, evidently due to a chronic appendix which was found at the same time. The adhesions were severed and the appendix removed. Subsequent roentgenograms showed the intussusception to have been completely reduced.

Fig. 13. Case V. Subacute intussusception in a child with chronic appendicitis.

SUMMARY

1. The relation of the roentgenological pictures to the anatomical varieties of chronic intussusception is considered.

2. The various and apparently bizarre pictures obtained are illustrated and described.

3. Five proved cases, with roentgenologic studies, are reported.

4. Comparison with the experimental studies of Brocq and Gueullette is made.

5. The importance of study of the colon following defecation after a barium enema is emphasized in the material presented.

6. This report, it is hoped, will again accentuate the necessity for conservatism in attempting etiologic diagnoses where obstructing lesions of the colon are found.

CONCLUSIONS

The following are offered as diagnostic criteria in intussusception:

1. Obstruction to the passage of barium either given by meal or enema but not often to both.

2. A filling defect at the site of the obstruction; various appearances are described in the article.

3. A palpable mass at the site of the obstruction.

4. A change in the position and shape of the filling defect following defecation.

5. A compression of the adjacent mucosal folds particularly well seen in the post-defecation films.

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ROENTGENOLOGY OF EXTRA-ALIMENTARY TUMORS*

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ROENTGENOLOGIC examination of the abdomen has become almost a routine measure in the elucidation of symptoms or physical findings suggesting alimentary or intra-abdominal disease. The gastrointestinal examination by means of the contrast meal is used in differentiating any palpable tumor which is not with certainty determined to be extra-alimentary and of an origin indicating urological or gynecological investigation. In the examination of such a palpable abdominal tumor, the gastrointestinal observations will determine in most instances whether its site is alimentary or extra-alimentary. Often without notable findings upon palpation of the abdomen, gastrointestinal roentgenology will reveal topographical alterations which will indicate previously undiscovered intra-abdominal masses. Gastrointestinal examination with the contrast medium has reached a very marked degree of refinement varying directly with the experience of the observer. It may be said that the method has achieved an almost certain differentiation of a palpable tumor as being intrinsic or extra-alimentary. Beyond the determination that any mass lies outside the alimentary tube, the contrast meal will usually show other attributes which will further aid in the diagnosis.

FIG. 1. Pancreatic cyst which was palpable in the left epigastrium appearing about the size of a large fist. The stomach is displaced to the left and downwards, developing a large circle from the lesser curvature. The median stomach is displaced anteriorly and compressed against the anterior parietes (Fig. 2). The duodenum is displaced to the right and the duodenojejunal juncture is displaced downwards. The retroperitoneal origin of this tumor was demonstrated and its physical characteristics, which were elucidated by roentgenoscopic palpation, made the diagnosis certain.

FIG. 2. Pancreatic cyst (same as in Figure 1.) showing in a lateral roentgenogram the anterior displacement and compression of the stomach. The orderly rugae in this and Figure 1 manifest the extragastric position of the tumor. Operative confirmation: Dr. Duff Allen.

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PANCREATIC TUMORS

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
1	R.G.	Mass size of grapefruit in left upper quadrant. Impression cystic, not tender.	Pancreatic cyst. See Figures 1 and 2.	Operation: Pancreatic cyst containing about 2000 cc. fluid. Cyst marsupialized.
2	J.E.	In standing position mass size of large orange suggestively cystic, palpable in epigastrium	Pancreatic cyst. See Figure 3.	Operation: Pancreatic cyst containing 3 quarts of fluid. Marsupialization.
3	A.L.H.	Large cystic mass, palpable, filling upper epigastrium.	Pancreatic cyst.	Operation: Pancreatic cyst containing 0.5 liter clear fluid. Cyst was marsupialized.
4	E.M.	Great palpable cystic tumor filling right upper quadrant and upper half of right lower quadrant.	Pancreatic cyst.	Operation: Large pancreatic cyst drained and marsupialized.
5	M.E.F.	Great visible and palpable cystic mass filling upper abdomen.	Pancreatic cyst.	Operation: Pancreatic cyst containing 2000 c.c. drained and marsupialized.
6	G.W.	Firm, smooth, suggestively cystic mass size of a large grapefruit fills the upper abdomen.	Pancreatic cyst. See Figure 4.	Operation: Marsupialization of pancreatic cyst.
7	V.I.	Firm, slightly irregular mass, size of grapefruit filling the right epigastrium.	Pancreatic cyst.	Operation: Pancreatic cyst (600 c.c.) marsupialized.
8	M.F.	Large cystic mass filling central and left epigastrium	Pancreatic cyst.	Operation: Marsupialization of pancreatic cyst.
9	W.H.	Large firm nodular mass palpable in upper abdomen.	Pancreatic cyst.	Autopsy: Carcinoma of pancreas with metastasis to retroperitoneal glands. Bronchopneumonia.
10	L.G.	Palpable mass size of orange in lower right epigastrium. Jaundice.	Extra-alimentary, retroperitoneal tumor of pancreatic origin, carcinoma.	Operation: Carcinoma of head of pancreas. Cholelithiasis. Cholecystectomy.
11	F.L.	Hard irregular mass size of two fists filling central upper abdomen.	Extra-alimentary tumor, pancreas. Neoplasm.	Operation: Carcinoma of pancreas.
12	J.G.	Hard egg-sized mass deep in lower median epigastrium.	Pancreatic lesion, nature indeterminate.	Operation: Carcinoma of pancreas.
13	M.A.R.	Sausage-shaped, hard irregular mass in lower mid-epigastrium.	Extra-alimentary tumor: of the pancreas? Carcinoma?	Operation: Carcinoma of middle portion of pancreas. Inoperable. Metastasis to omentum.

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
14	M.E.	Deep hard mass size of orange in lower epigastrium.	Extra-alimentary tumor: Neoplasm of pancreas?	Operation: Carcinoma of body of pancreas.
15	W.C.	Large hard mass in left upper epigastrium; left lobe of liver.	Enlarged liver.	Operation: Carcinomatous mass size of a lemon in head of pancreas. Metastasis to liver.
16	H.C.P.	Abdomen distended by large hard palpable mass in right upper quadrant, evidently liver.	Extra-alimentary abdominal malignancy? Hepatic enlargement.	Considered inoperable carcinoma of the pancreas with metastasis to liver.
17	C.B.	Abdomen large due to ascites and enlarged liver.	Extra-alimentary tumor (liver). Ascites. See Figure 5.	Autopsy: Carcinoma of head of pancreas with metastasis to liver.
18	I.D.	Tumor 20 x 11 cm., smooth with suggestive notch on right border, palpable in left upper quadrant extending a little to right of midline.	Large ovoid tumor, left upper abdomen, probably of renal origin.	Operation: Tumor of pancreas. Pathological report: Intracystic papillary adenoma.

MISCELLANEOUS TUMORS ENLARGING CIRCLE OF DUODENUM

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
19	F.B.	Stony hard nodular mass, size and shape of a small fist, palpable in upper right epigastrium.	Extra-alimentary tumor, pancreatic, carcinomatous.	Operation: Sarcoma of testicle. Sarcoma of retroperitoneal lymph nodes.
20	J.L.	Large mass in central abdomen, slightly to left of midline, fixed.	Extra-alimentary tumor, pancreatic.	Excision of tissue from tumor of scrotum was teratoma. Teratomatous metastasis to retroperitoneal lymph glands.
21	R.Y.	Abdomen greatly distended making palpation unsatisfactory. Scar of recent exploratory operation on common bile duct.	Alimentary displacements of extreme degree by mass arising retroperitoneally, hydrops (biliary) of lesser peritoneum.	Operation: Retroperitoneal space filled with bile. See Figure 6.

OTHER TUMORS OF UPPER CENTRAL ABDOMEN

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
22	R.G.	Deep indefinite mass, size of large fist, in upper epigastrium indefinite consistency, probably pulsatile. No respiratory excursion.	Extra-alimentary upper abdominal tumor. Aneurysm.	Final hospital diagnosis: Aneurysm of abdominal aorta. Syphilis.

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
23	L.J.	Liver palpable in right upper quadrant to level of umbilicus. Smooth mass deep in epigastrium over which there is a musical murmur.	Extra-alimentary tumor. Aneurysm. Hepatic enlargement.	Final diagnosis: Aneurysm of abdominal aorta. Cirrhosis of liver. Syphilis.
24	J.R.	Great fullness in right and adjacent left epigastrium, without respiratory excursion, and markedly pulsatile.	Extra-alimentary upper abdominal tumor. Aneurysm.	Autopsy: Ruptured aneurysm of descending aorta. Syphilis, etc.
25	M.S.	Large mass occupying entire upper central abdomen.	Extra-alimentary tumor. Tuberculous glands.	Tuberculosis, miliary. Tuberculous glands.
26	O.R.	Palpable tumor, size of a grapefruit in mid-abdomen. Mass is hard, nodular and slightly movable.	Extra-alimentary tumor, omental? Malignant?	Operation: Thick plaques of colloid carcinoma filling upper abdomen. Origin obscure.
27	T.B.W.	Great mass occupying upper half of abdomen, has smooth surface and rather soft.	Dislocation of viscera by great abdominal mass (cyst?).	Operation and autopsy. Spindle celled sarcoma of great omentum with invasion of the liver.
28	J.B.C.	Abdomen greatly distended. Question of mass in left central upper abdomen. Shifting dullness in flanks.	Inflammatory mass of indeterminate origin.	Operation: Mesenteric abscess going down to head of pancreas and then up behind duodenum.

TUMORS OF THE LEFT KIDNEY

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
29	G.L.S.	Large mass filling left upper abdomen, hard, fixed, not tender.	Extra-alimentary tumor, retroperitoneal origin, left upper abdomen. Hypernephroma?	Biopsy cervical glands of neck revealed metastatic hypernephroma. See Figures 7 and 8.
30	E.P.	Large mass filling left upper abdomen.	Extra-alimentary tumor, left upper abdomen. Hypernephroma?	Operation: Hypernephroma, left kidney.
31	F.G.	Large mass occupying left upper abdomen.	Neoplasm occupying left upper abdomen. Hypernephroma?	Operation: Hypernephroma, left kidney.
32	O.H.	Large mass in left upper abdomen.	Extra-alimentary tumor: Hypernephroma, left.	Operation and autopsy: Hypernephroma, left kidney. Metastasis, etc.
33	M.C.	Great lobulated tumor occupying entire left upper quadrant.	Extra-alimentary tumor. Kidney neoplasm.	Operation: Papillary carcinoma of kidney pelvis.

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
34	N.J.	Mass size of orange in right upper abdomen, fixed, soft and slightly tender.	Extra-alimentary tumor. Malignancy of left kidney?	Operation: Papillary carcinoma of left kidney. Metastasis of liver.
35	F.C.	Mass in left upper abdomen size of average grapefruit, feels cystic.	Extra-alimentary tumor.	Operation: Solitary retention cyst of left kidney.
36	C.D.	Great mass filling left upper abdomen, extending 3 cm. below umbilicus and to right border of right rectus muscle.	Pancreatic cyst.	Operation: Cystoma of left kidney.
37	V.L.Z.	Large tumor of left upper abdomen.	Extra-alimentary retroperitoneal tumor. Left kidney?	Operation: Malignant fetal tumor of left kidney.

SPLENOMEGALY

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
38	S.N.	Tumor (spleen) palpable 3 finger-breadths below left costal margin and extends to within 3 cm. of midline.	Splenomegaly.	Final hospital diagnosis: Chronic splenic tumor.
39	W.A.	Mass in left upper quadrant size of kidney, rather deep and lobulated.	Extra-alimentary tumor; hypernephroma.	Operation: Normal kidney. Spleen enlarged. Chronic splenic tumor.
40	M.P.	Large mass in left upper abdomen resembles enlarged spleen.	Splenomegaly.	Operation: Splenectomy. Banti's disease.
41	R.M.	Spleen palpable to level of umbilicus.	Splenomegaly.	Final hospital diagnosis: Banti's disease.
42	A.W.	Spleen palpable almost to level of umbilicus.	Splenomegaly.	Final hospital diagnosis: Banti's disease.
43	A.M.M.	Spleen palpable to 5 cm. below level of umbilicus.	Splenomegaly.	Final hospital diagnosis: Splenic anemia.
44	B.M.	Large mass in left upper abdomen.	Enlarged spleen?	Final hospital diagnosis: Splenic anemia.
45	J.E.T.	Large mass in left lateral abdomen.	Enlarged spleen. See Figure 9.	Final hospital diagnosis: Pernicious anemia.
46	J.J.	Spleen palpable to level of iliac crest and extends almost to midline.	Splenomegaly.	Final hospital diagnosis: Chronic aleucemia.

OTHER TUMORS OF LEFT UPPER ABDOMEN

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
47	D.K.	Mass in left upper quadrant, lower pole at umbilicus, right border at midline; smooth, hard, fixed.	Retroperitoneal tumor, left median upper abdomen possibly sarcoma.	Operation: Enlarged fibroma of peritoneum removed from behind posterior peritoneum.
48	H.A.R.	Mass in left upper quadrant of abdomen.	Retroperitoneal tumor in left upper abdomen.	Final diagnosis: Tumor of retroperitoneal glands.
49	E.D.	Large lobulated mass in left hypochondrium.	Extra-alimentary tumor, left upper abdomen. Sarcoma? Metastatic?	Operation and autopsy: Malignant tumor of vertebra.
50	M.L.W.	Large multilobular mass filling almost entire left upper abdomen.	Extra-alimentary tumor, left upper abdomen. See Figures 10 and 11.	Operation: Chromaffinoma, arising from adrenal cell rest.

HEPATIC TUMORS

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
51	T.C.	Large tumor of right upper abdomen extending downward to crest of ilium.	Hepatic enlargement.	Final hospital diagnosis: Cholelithiasis; jaundice; stenosis of gall duct; chronic cholecystitis.
52	S.G.	Mass palpable in right upper abdomen.	Carcinoma of liver. Secondary?	Operation: Adenocarcinoma of liver, primary.
53	H.W.	Rather large mass extends downward from liver in right abdomen.	Enlargement of liver. Metastatic?	Operation: Carcinoma of liver, primary, arising from bile ducts.
54	M.S.	Mass, liver, palpable in upper abdomen.	Hepatic tumor.	Final diagnosis: Carcinoma of liver, primary.
55	B.H.	Liver enormously enlarged, extends almost to pubic bone.	Hepatic enlargement. See Figure 12.	Operation and autopsy: Multilocular cyst of liver.
56	C.N.	Great mass occupying upper two-thirds of abdomen.	Hepatic enlargement.	Operation: Multilocular cyst of liver.
57	H.S.	Large multilocular mass filling upper three-fifths of abdomen.	Tumor of liver.	Final hospital diagnosis: Carcinoma of liver, secondary to carcinoma of prostate.
58	J.R.B.	Liver greatly enlarged. Ascites.	Pelvic extra-alimentary tumor. Hepatic enlargement.	Final hospital diagnosis: Carcinoma of prostate. Metastasis to liver.
59	E.V.	Liver enlarged to level of umbilicus.	Hepatic enlargement.	Final hospital diagnosis: Hypertrophic cirrhosis of liver.
60	M.N.	Large mass occupying all of epigastrium and right upper quadrant.	Enlarged liver. See Figure 13.	Final hospital diagnosis: Hypertrophic cirrhosis of liver.

TUMORS OF THE RIGHT KIDNEY

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
61	H.S.	Hard mass in right lower quadrant the size of a large fist. Liver palpable full hand breadth below right costal margin.	Extra-alimentary tumor, carcinoma of liver.	Final hospital diagnosis: Hypernephroma of right kidney. Metastasis to liver.
62	A.B.	Large mass 20 cm. in diameter occupying right side of abdomen.	Pancreatic cyst? See Figure 15.	Operation: Spindle cell carcinoma of right kidney.
63	L.B.	Mass size cantaloupe filling entire right upper abdomen.	Hypernephroma, right kidney.	Autopsy: Hypernephroma right kidney with metastasis to the lungs, brain, etc.
64	J.B.K.	Large mass filling entire right upper quadrant.	Extra-alimentary tumor. Kidney tumor?	Final hospital diagnosis: Hypernephroma of right kidney.
65	J.A.	Mass size of fist in middle right abdomen.	Extra-alimentary tumor, of renal origin?	Final hospital diagnosis: Hypernephroma of right kidney. Metastasis to lung.
66	R.W.	Great mass filling entire lower two-thirds of abdomen.	Extra-alimentary tumor, arising posteriorly. Teratoma?	Operation and autopsy: Sarcoma of kidney with metastasis to glands, liver, lungs, etc.
67	J.A.H.	Mass size of grapefruit in right upper quadrant.	Right upper abdominal tumor of renal origin (Fig. 14).	Operation: Hydronephrosis right kidney.

OTHER TUMORS OF RIGHT UPPER ABDOMEN

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
68	V.L.	Mass size of fist in right upper abdomen.	Extra-alimentary tumor, enlarged gall-bladder?	Operation: Peritoneal abscess, probably cholecystic in origin.
69	B.B.	Large irregular mass occupying left central abdomen.	Extra-alimentary tumor, of indeterminate origin.	Operation: Lymphosarcoma of mesenteric glands. Primary course not found.
70	A.B.	Great palpable mass occupying practically entire upper three-fourths of abdomen.	Extra-alimentary tumefaction of indeterminate origin. See Figure 22.	Autopsy: Tuberculosis of peripancreatic and retroperitoneal lymph nodes.
71	M.O.	Large pear-shaped mass in right upper abdomen.	Hydrops of gall-bladder.	Hydrops of gall-bladder confirmed roentgenologically.
72	J.R.	Mass size of small grapefruit in right upper abdomen.	Extra-alimentary tumor; mesenteric cyst.	Operation: Cyst of mesentery.

TUMORS OF LEFT OVARY

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
73	S.M.	Massive lobulated tumor filling lower left abdomen.	Extra-alimentary tumor, left lower abdomen.	Operation: Massive ovarian tumor, carcinomatous.
74	L.L.	Mass, palpable, rising from lower left pelvis.	Extra-alimentary tumor, mesenteric metastasis.	Operation and autopsy: Carcinoma of left ovary with extensive metastasis.
75	I.B.	Mass size of large orange in left lower abdomen.	Extra-alimentary tumor (ovarian).	Died, final diagnosis: Carcinoma of left ovary.
76	M.E.T.	Large nodular mass filling entire pelvis, extending upward on left to umbilicus.	Extensive pelvic neoplasm with involvement of pelvic colon.	Operation: Carcinoma of left ovary with extension to peritoneum.
77	J.M.S.	Mass presenting above symphysis to left of midline.	Pelvic tumor, involving sigmoid colon.	Operation: Cystoma of left ovary.
78	M.H.	Large mass occupying lower mid-abdomen.	Ovarian cyst.	Operation: Cystoma of left ovary.
79	B.M.	Mass size grapefruit in left lower abdomen.	Extra-alimentary pelvic tumor, left. See Figure 19.	Operation: Large ovarian cyst containing 1000 c.c. fluid.
80	L.M.	Great palpable mass occupying lower median abdomen.	Ovarian cyst.	Operation: Cystoma of ovary.
81	I.L.	Great smooth tumor presenting and filling entire anterior abdomen.	Extra-alimentary tumor, cystic.	Operation: Cystoma of left ovary.
82	K.B.	Large mass filling upper and central abdomen.	Extra-alimentary tumor of pelvic origin.	Operation: Cystadenoma of left ovary.
83	G.A.	Tumor size of cantaloupe occupying entire central abdomen.	Ovarian teratoma. See Figure 22.	Operation: Ovarian teratoma.
84	H.C.	Tumor arising from left pelvis extending to within 3 cm. of level of umbilicus.	Extra-alimentary tumor, left pelvis.	Operation: Dermoid cyst of left ovary.
85	C.S.	Mass size of two fists occupying left lower abdomen.	Extra-alimentary tumor, left lower abdomen.	Operation: Dermoid cyst of ovary
86	S.M.	Large tumor in left lower abdomen arising from pelvis.	Extra-alimentary left pelvic tumor.	Operation: Abscess involving left ovary.

ONE OTHER TUMOR OF LEFT LOWER ABDOMEN

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
87	J.J.	Large mass occupying most of left lower abdomen.	Tumor, left lower abdomen, involving distal colon.	Operation: Dense mass of indurated fat surrounding the sigmoid colon.

TUMORS OF RIGHT OVARY

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
88	S.T.	Tumor not palpated prior to roentgen examination.	Tumor in right pelvis. See Figure 21.	Final hospital diagnosis: Cyst of right ovary.
89	B.M.E.	Tumor palpable bimanually in right adnexal region.	Pelvic tumor, right.	Final hospital diagnosis: Cystoma right ovary.
90	E.F.	Large mass presenting in right iliac fossa.	Extra-alimentary tumor, right pelvis.	Operation: Cystoma of right ovary.
91	E.S.	Mass palpable low in right lower abdomen.	Extra-alimentary right pelvic tumor.	Final hospital diagnosis: Cystoma of right ovary.

OTHER TUMORS OF RIGHT LOWER ABDOMEN

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
92	G.J.R.	Tumor filling the left lower quadrant.	Extra-alimentary tumor, of pelvic origin. Abscess.	Operation: Large subcutaneous abscess communicating with an enormous abscess filling the right lower abdomen and pelvis.
93	V.P.	Long irregular tumor extending from umbilicus downward and to right.	Mesenteric adenitis.	Operation: Tuberculous mesenteric lymph nodes.
94	F.P.	Mass size 12×6 in. in extreme right lower abdomen. Mass size of lemon in right upper epigastrium.	Extra-alimentary tumor, indeterminate origin.	Operation and autopsy: Lymphosarcoma arising in right inguinal gland with metastasis to regional lymph glands.
95	S.H.	Spherical tumor in right lower abdomen.	Extra-alimentary tumor. Carcinoma? Omental?	Operation: Cyst of retroperitoneal tissue between cecum and spine.
96	J.S.	Great intra-abdominal cyst involving chiefly the right abdomen.	Extra-alimentary tumor, right. Origin indeterminate.	Operation and autopsy: Cystic Meckel's diverticulum.
97	S.A.	Prominent mass 10 cm. in diameter in right lower abdomen.	Extra-alimentary tumor, of indeterminate nature.	Operation: Inflammatory mass consisting mostly of omentum.
98	A.D.	Indefinite palpable resistance in right lower abdomen.	Extra-alimentary tumor, probably abscess, of appendicial origin. See Figure 23.	Operation: Appendix was ruptured at base but there was no collection of pus. Many fresh adhesions.

UTERINE TUMORS

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
99	A.R.	Mass size of orange palpable on deep pressure immediately above symphysis.	Gravid uterus. See Figure 16.	Childbirth.
100	M.S.	Uterus palpable almost to umbilicus.	Gravid uterus.	Childbirth.
101	E.S.	Uterus not palpable abdominally. Ten weeks' gestation.	Gravid uterus.	Childbirth.
102	O.M.J.	Uterus not palpable except bimanually.	Gravid uterus.	Childbirth.
103	M.W.	Upper half of mass arising from pelvis palpable above symphysis pubis.	Gravid uterus.	Childbirth.
104	F.B.	Uterus not palpable abdominally.	Gravid uterus.	Childbirth.
105	S.B.	Uterus not palpable abdominally.	Gravid uterus.	Operation: Cholecystectomy. Uterus about two month's gestation.
106	P.R.	Mass size of large grapefruit extending upward from left pelvis.	Extra-alimentary tumor of pelvic origin.	Final hospital diagnosis: Carcinoma of uterus.
107	E.B.	Pelvic tumor palpable bimanually.	Extra-alimentary pelvic tumor.	Autopsy: Carcinoma of cervix with invasion of pelvic structures.
108	A.H.	Large hard mass arising from pelvis.	Extra-alimentary pelvic tumor.	Autopsy: Carcinoma of pelvic organs with extension to regional lymph nodes and liver.
109	N.N.	Great palpable mass filling lower abdomen.	Great extra-alimentary pelvic tumor.	Final hospital diagnosis: Carcinoma of uterus. X-ray therapy.
110	L.L.	Mass size of orange palpable on recto-abdominal bimanual palpation.	Fibroid of uterus.	Final hospital diagnosis: Myoma of uterus.
111	L.S.	Large nodular mass filling entire left lower abdomen.	Fibroid of uterus.	Operation: Fibroma of uterus.
112	A.M.	Mass size of grapefruit in left lower abdomen.	Extra-alimentary tumor, left lower abdomen.	Final hospital diagnosis: Myoma of uterus.
113	A.W.	Abdomen distended. Indefinite mass in lower zone.	Extra-alimentary pelvic tumor, fibroids.	Operation: Myoma of uterus, calcified.

114	S.N.	Upper border of mass can be felt above symphysis pubis.	Fibroma. See Figure 24.	Operation: Myoma of uterus with hyaline degeneration.
115	J.C.	Large bilobular tumor extending upward from pelvis.	Extra-alimentary pelvic tumor.	Operation: Myoma of uterus.
116	A.H.	Multilobular tumor in lower abdomen.	Fibroid of uterus.	Final hospital diagnosis: Myoma of uterus.
117	M.A.	Large mass in left lower abdomen.	Extra-alimentary tumor of pelvic origin.	Final diagnosis: Myoma of uterus.
118	T.C.R.	Suprapubic tumor size of orange.	Extra-alimentary pelvic tumor.	Final hospital diagnosis: Myoma of uterus.
119	A.H.	Uterine mass palpable on vaginal examination.	Fibroid of uterus; calcified.	Operation: Myoma of uterus.
120	V.G.	Tumor palpable suprapubic.	Pelvic tumor.	Operation: Chronic subinvolution of uterus.

OTHER CONDITIONS OF LOWER ABDOMEN

Case No.	Initials	Palpable Findings	Roentgen Diagnosis	Confirmation
121	F.E.	Abdomen markedly distended.	Displacement of viscera as from extra-alimentary pelvic tumor	Exploratory operation entirely negative. Final diagnosis: Hysteria.
122	W.G.	Not notable.	Distal colonic redundancy causing displacement of small intestine. See Figure 18.	
123	G.W.	Not notable.	Distal colonic redundancy causing displacement of small intestine.	
124	G.W.T.	Questionable palpable mass low in right abdomen.	Lesion of upper rectum resulting in colonic obstruction. Carcinoma?	Operation: Abscess between bladder and rectum of origin probably from perforation of malignant ulcer or diverticulitis. No evidence of malignancy found.
125	R.M.G.	Not notable.	Pelvic tumor causing compression of distal rectum.	Operation: Teratoma of sacrum.
126	M.V.	Large pelvic mass palpable abdominally.	Extra-alimentary pelvic tumor.	Operation: Muliple neurofibromatosis.

FIG. 3. Pancreatic cyst without localized palpable findings. The patient had previously received a diagnosis of carcinoma of the stomach and a hopeless prognosis. The stomach is displaced into the upper right epigastrium in a manner to create a pocketing of the fundus and to obscure the duodenal cap behind the pylorus. The transverse colon is displaced downward from the stomach and with the enema (below) describes the lower contour of the mass. The duodenojejunal juncture is displaced downwards. Operative confirmation: Dr. Evarts A. Graham.

Changes in the topography and contour of the alimentary segments are more or less pronounced and significant. As a direct corollary the contour of the mass will be delineated. The attachment will be shown. The size will be better indicated. The manner of the displacements and of the impression made upon the barium-filled tract will indicate the extra- (retro-) peritoneal or intraperitoneal origin of the mass. Palpation of the abdomen with roentgenoscopic control will further develop those attributes which may be recorded by films, and will in addition demonstrate mobility and tenderness. Although the literature of alimentary roentgenology is voluminous, relatively little appears about this phase of the findings of gastrointestinal examination. Many single cases of extra-alimentary tumor have been reported in which the roentgenologic gastrointestinal examination has assisted in a more or less important way. Pansdorf and Kraas have recently described the roentgenology of extra-alimentary abdominal tumors. Bird in an excellent paper upon the tumors expanding the curvature of the duodenum, reviews case reports by Case, Assmann and Schwarz. He finds that the expansion of the circle of the duodenum is most frequently caused by a pathologic process involving the retroperitoneal lymph nodes, such as lymphosarcoma, Hodgkin's disease, metastatic carcinoma or tuber-

FIG. 4. Pancreatic cyst was palpable as a large, firm, smooth mass, with only slight mobility, filling the epigastrium. The distal stomach is displaced upwards and compressed and the circle of the duodenum is enlarged and displaced to the right without disturbance of its motility or disorder of the rugae. Operative confirmation: Dr. Glover Copher.

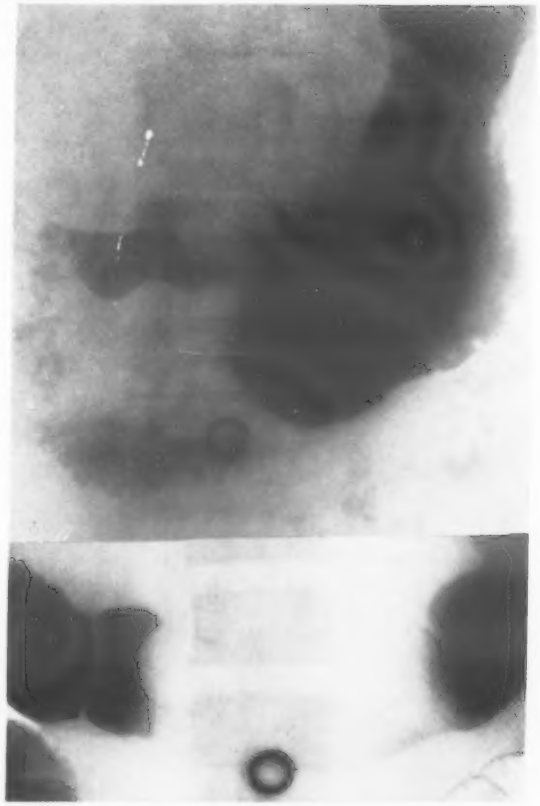

FIG. 5. Cancer of pancreas. Large, hard, nodular mass palpable in central abdomen. The distal stomach is displaced upwards and deformed but exhibited orderly rugae. The circle of the duodenum is slightly enlarged and the rugae are intact. The transverse colon (below) showed the effect of pressure and the irritability of secondary involvement of its peritoneum. Confirmation at autopsy.

FIG. 6. Lesser peritoneum distended by bile. The abdominal distention which gradually developed during two weeks after operation gave no localizing signs. The stomach is shown flattened above against the diaphragm and anteriorly against the anterior parietes, and roentgenoscopically barium would canalize the pyloric stomach only when the deglutition pressure became sufficient to open the lumen. The barium would then escape into the duodenum at A. Operative interference by Dr. E. A. Graham, evacuated 3 liters of bile from the lesser sac and the patient recovered. Roentgenological studies afterwards found the stomach in usual position.

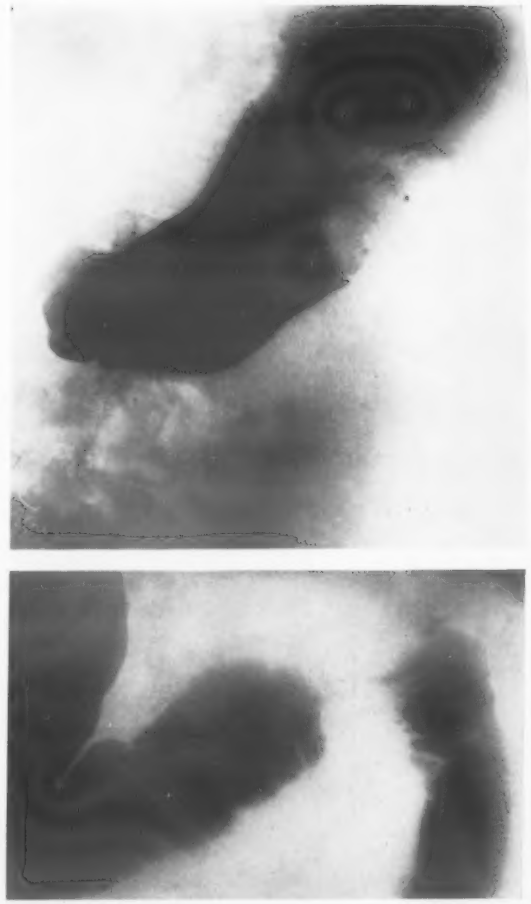

FIG. 7. Hypernephroma of left kidney presenting a large mass filling upper left abdomen. The stomach is elevated and shows pressure effect of the mass. The anteroposterior contour is normal on overfilling of the stomach. The rugae are normal. In lateral view the medial stomach is markedly displaced anteriorly. The circle of the duodenum is undisturbed. The splenic flexure and distal transverse colon (below) show pressure effect of contiguous mass. There was difficulty of canalization by barium enema due to extraneous pressure.

FIG. 8. (Same case as Figure 7.) Barium enema in lateral view shows displacement of splenic flexure and descending colon anteriorly. Confirmation: Biopsy on cervical glands showed metastatic hypernephroma.

FIG. 9. Splenomegaly associated with pernicious anemia and malaria (tertian). A large mass was palpable in the left upper abdomen. The stomach is displaced to the right and the splenic flexure is dislocated downward. The small intestine was likewise displaced to the right and downward.

culosis. In the series reported in this paper tumors of the pancreas have been more frequent in enlarging the circle of the duodenum.

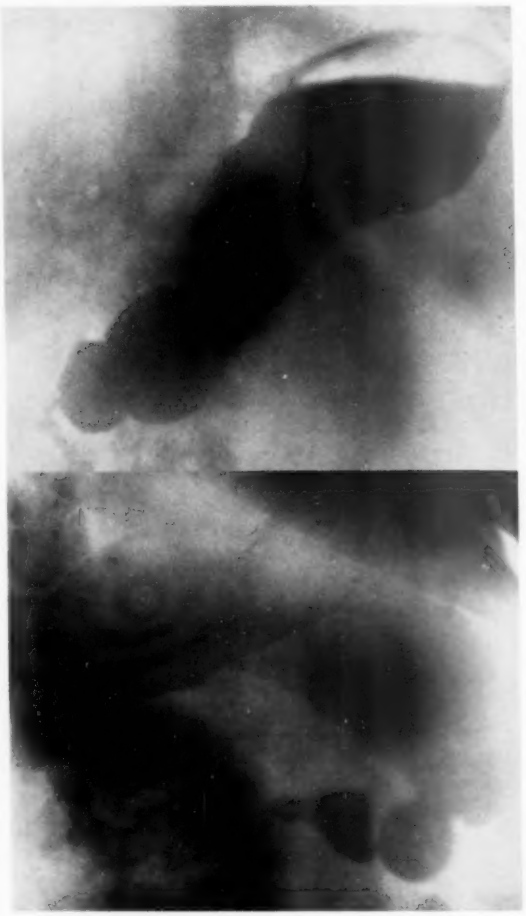

FIG. 10. Chromaffinoma arising from left adrenal. A large multilobular mass was palpable in the left upper abdomen. The stomach is displaced to the right, upward, and anteriorly. The second and third portions of the duodenum are dislocated to the right. In lateral view (below) the stomach is shown displaced upward and anteriorly, and circumscribes the right and upper borders of the mass.

The method of the gastrointestinal roentgenological procedure must be inclusive of adequate visualization of all the abdominal portion of the tract. Beyond this essential, the details of the technique may suit the personal habits of any observer. Roentgenoscopy and roentgeno-

graphy will both contribute to the conclusions. In the method used in this series of cases the contrast meal is given to the fasting patient in the morning. Roentgenoscopic observation is then made in all planes, and vertical, anteroposterior films are exposed; when necessary, prone and lateral films are made. Observations and films are made again at six, and at twenty-four hours after the meal is taken. The patient is allowed food and drink only after the six-hour period. At forty-eight hours an opaque enema is given under roentgenoscopic control and films are made. The findings of these several roentgenoscopic observations are afterwards summarized with the help of the assembled roentgenograms.

This report is based upon the findings in 126 cases of intra-abdominal extra-alimentary tumors encountered in examinations of the alimentary tract by the contrast meal. Tumors causing displacement and changes in the esophagus have been omitted from this study as their complete separation from the abdominal field by the diaphragm removes them from any direct association and from the problem of mutual differentiation.

FIG. 12. Multilocular cyst of liver. Palpable mass filling entire right abdomen and extending downward well below the umbilicus. The stomach is dislocated markedly to the left. The antrum and duodenal bulb are displaced downward and to the left, as is also the small intestine.
Operative confirmation: Dr. Evarts S. Graham.

FIG. 11. (Same case as Figure 10.) The splenic flexure surrounds the upper portion of the mass which has presented from the posterior left upper abdomen between and by separating the arms of the splenic flexure. Operative confirmation: Dr. Evarts A. Graham and Dr. John R. Caulk.

There were 21 cases of tumors found in the upper abdomen or epigastrium. Eighteen originated in the pancreas. Three were retroperitoneal and independent of the pancreas. Of these three, two were enlargements of the retroperitoneal lymph glands, one by metastatic sarcoma from the testicle, and the other by teratoma originating in the scrotum. The third was an accumulation of bile within the lesser omentum after exploration of the common bile duct. The tumors of pancreatic origin were 8 pancreatic cysts and 10 primary carcinomata.

Fig. 13. Hypertrophic cirrhosis. Palpable mass filling entire right upper abdomen and extending into right lower abdomen. The hepatic flexure is displaced downward and shows pressure effect of enlarged liver.

Fourteen of the 18 were recognized. Of the 4 tumors which were unrecognized as of pancreatic origin, 3 gave no significant alteration of the duodenum and one was erroneously thought to be of the left kidney. In the latter, the duodenum was unaltered and there was a pressure deformity of the greater curvature of the stomach and of the splenic flexure of the colon, both of which were displaced slightly anteriorly. The experience with pancreatic cysts demonstrates how they may present in varying positions and may cause different topographical derangements of the alimentary tract (see Figs. 1, 2, 3, 4, 5 and 6).

There were 7 cases of tumor of the upper central abdomen which did not influence the circle of the duodenum. None of these were of the pancreas. Three were abdominal aneurysms: one was a large mass of tuberculous glands; another was an adenocarcinoma with colloid degeneration of indeterminate origin; another was a spindle cell sarcoma of the great omentum; and the seventh consisted of multiple abscesses of the mesentery. There were no characteristic displacements which would permit roentgenologic aid in the diagnosis beyond that it was possible to say they were definitely extra-alimentary.

Of the tumors involving the left upper abdomen, 9 were of the kidney, 9 of the spleen and 4 were of miscellaneous origin. The renal tumors were 4 hypernephromata, 2 papillary carcinomata, 2 cysts, and one malignant fetal tumor. All of the renal cases had gastrointestinal roentgenology prior to pyelography. One case was erroneously diagnosed a pancreatic cyst. The displacements by this were unusual. The stomach was displaced to the right and anteriorly. The duodenum was also displaced to the right and the duodenojejunal juncture was

Fig. 14. Hydronephrosis, right. Mass size of a grapefruit palpable in right upper abdomen. The stomach (inset) is displaced markedly to the left. The distal second duodenum which normally crosses the lower pole of the right kidney is displaced upward and to the left. The hepatic flexure is displaced downward and to the left, and this portion of the colon reflects the contour and impression of the tumor, but is not otherwise involved. Operative confirmation: Dr. D. K. Rose.

FIG. 15. Carcinoma of the right kidney. Large mass occupying entire right side of abdomen and extending partially into left abdomen. The displacements in this case, particularly those of the colon are atypical for kidney tumor. The stomach (inset) is displaced to the left and elevated. The duodenum is dislocated upward and to the left. The hepatic flexure is displaced upward and outward. The root of the mesentery is dislocated downward. Operative confirmation: Dr. D. K. Rose.

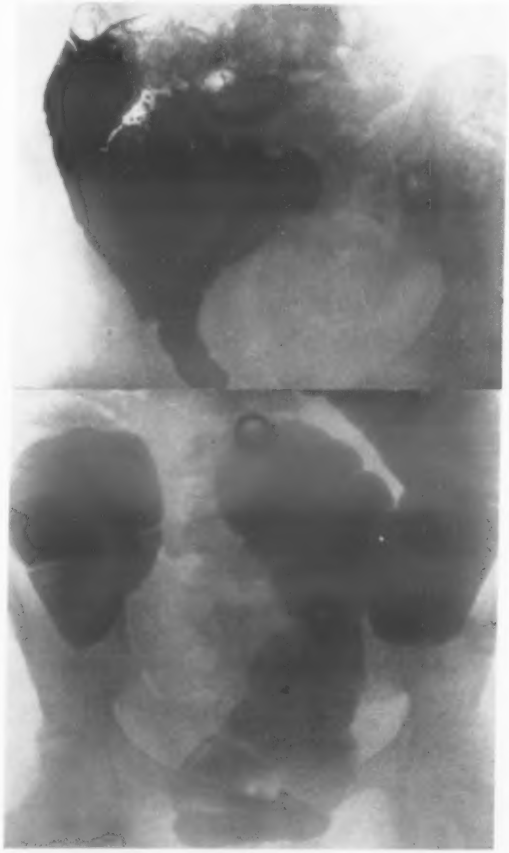

FIG. 16. Early pregnancy. Mass not palpable abdominally. The small intestine (above) is dislocated upward from the pelvis and also to the right. The rectum (below) shows pressure effect of gravid uterus.

FIG. 17. Later stage of pregnancy. Uterus palpable to level of umbilicus. The small intestine (above) is completely elevated from the pelvis and the loops are fairly evenly distributed. The distal colon (below) is displaced markedly upward and to the right and shows pressure effect upon the rectum and sigmoid.

FIG. 18. Redundancy of pelvic colon resulting in displacement of small intestine. The ileum (above) displaced markedly upward by large redundancy of the distal colon (below).

displaced to the right and anteriorly. The distal transverse colon was displaced downward but not anteriorly (Figs. 7 and 8).

There were 9 instances of splenomegaly, one of chronic splenic tumor, 5 of Banti's disease, one of splenic anemia, one of pernicious anemia, and one of chronic aleucemia. The spleen could not always be identified by its physical characters, and when the bood showed no typical dyscrasia, other help was useful. In one case of splenomegaly the diagnosis was completely missed. Pyelograms suggested pathology in the left kidney. The stomach was dislocated to the right and elevated slightly, which is not the displacement that usually results from an enlarged spleen. Also, the descending colon was displaced downwards and medially, with the splenic flexure moved to the right rather than downward as is usual with splenomegaly. A roentgenological diagnosis of renal tumor was made (Fig. 9). Exploratory operation by Dr. John R. Caulk revealed a normal kidney. The spleen was enlarged and densely adherent to surrounding structures. Pansdorf and Kraas report a case of confirmed splenomegaly with normal topography of the colon.

Four other tumors in the left upper abdomen were neither splenic nor renal. One was a fibroma of the peritoneum, retroperitoneal in position. There were no roentgenological changes in the topography of the stomach or intestines. The diagnosis was a retroperitoneal tumor in the left median upper abdomen, possibly sarcoma. Another was a tumor of the retroperitoneal glands; the third was a malignancy of the upper lumbar vertebrae; and the fourth case a chromaffinoma. This last tumor caused the interesting displacements shown in Figures 10 and 11.

In the right upper abdomen 10 tumors

FIG. 19. Ovarian cyst, left. Palpable mass in left lower abdomen. The small intestine (inset) is dislocated from the left pelvis. There is partial obstruction in the sigmoid colon, but the luminal markings are more suggestive of extrinsic pressure effect than of intrinsic organic lesion. Operative confirmation: Dr. Q. U. Newell.

involved the liver, 7 were of the right kidney and 5 were of miscellaneous origin. Of the 10 cases of liver enlargement, one accompanied cholelithiasis with jaundice; 3 were primary carcinoma of the liver; 2 were multilocular cysts (Fig. 12); 2 were metastatic carcinomata from the prostate, and 2 were hypertrophic cirrhosis (Fig. 13). The physical attributes of these tumors did not identify them as of hepatic origin.

Of the 7 tumors of the right kidney, 5 were hypernephromata, one a sarcoma, and one a hydronephrosis. Gastrointestinal roentgenology preceded pyelography in these cases because of their admission to the general medical service. The roentgenological findings in 4 indicated a renal tumor (Figs. 14 and 15). In the other 3, less characteristic displacements led to false diagnoses. In one instance the metastatic enlargement of the liver obscured the small primary carcinoma in the kidney.

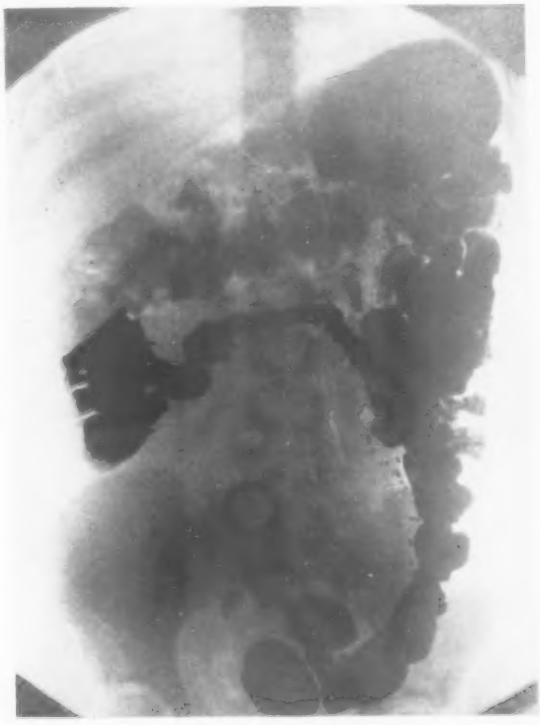

Fig. 20. Teratoma of left ovary in a child nine years old. Large palpable tumor occupying entire central abdomen. The stomach is dislocated upward and slightly to the left. The small intestine is dislocated en masse into the left upper quadrant, the terminal ileum crossing the abdomen well above the umbilicus but evidently below the upper margin of the tumor. The cecum is dislocated upward. The transverse colon is displaced upwards above the tumor. Operative confirmation: Dr. M. B. Clopton.

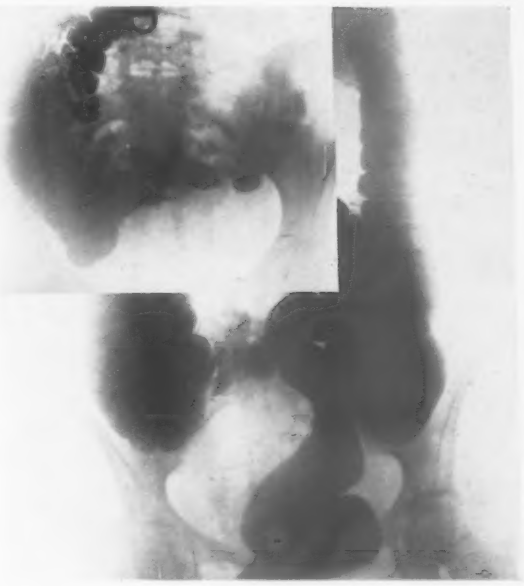

Fig. 21. Right ovarian cyst. Mass not palpable abdominally. The small intestine (inset) is displaced upward from the pelvis. The cecum is not greatly affected because of small size of tumor. The proximal rectum is displaced to the left and the rectosigmoid juncture is moderately narrowed due to pressure effect. Operative confirmation.

The second was erroneously diagnosed a tumor of the pancreas. The stomach and duodenum were displaced upward and outward, and the root of the mesentery downward. This suggested a pancreatic cyst. Pyelography disclosed the renal origin of the mass.

The third case was erroneously diagnosed retroperitoneal glands. The tumor was low and the terminal ileum crossed it anteroposteriorly. Pyelography again established the renal origin. A large sarcoma of the kidney was found at operation.

There were 5 tumors of the right upper abdomen which did not have their origin in the liver or kidney. One was a peritoneal abscess which had its origin from a cholecystitis; another was a mass of en-

larged mesenteric glands, which microscopically showed a lymphosarcoma; the third was a mass of retroperitoneal tuberculous glands; the fourth was a hydrops of the gall-bladder, and the fifth was a mesenteric cyst. All were determined to be extra-alimentary and the nature of the gall-bladder enlargement and of the mesenteric cyst was suggested.

ments of the small intestines which may occur from physiological tumors (Figs. 16 and 17), the full urinary bladder, and the filled redundant loops of the sigmoid (Fig. 18). The gravid uterus may also reveal itself in these gastrointestinal studies when the condition is not clinically mentioned.

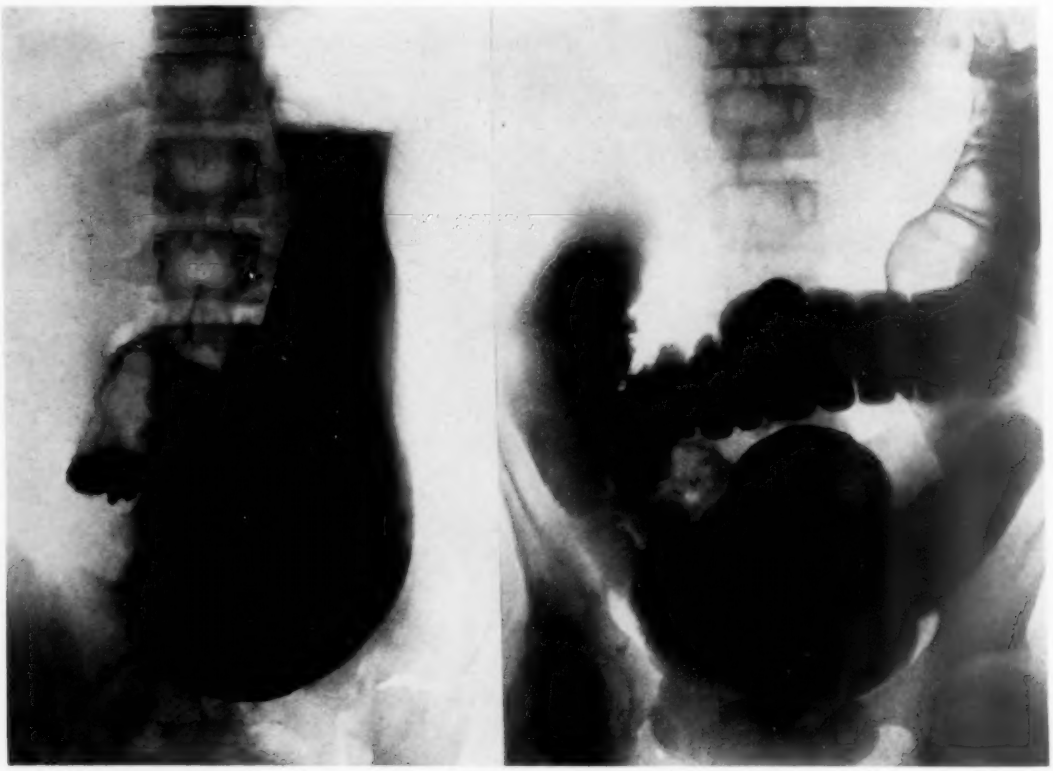

Fig. 22. Mass of tuberculous mesenteric lymph nodes. A long irregular mass was palpable extending from area of umbilicus downward and to the right. Contour of distal stomach is altered due to pressure effect of the mass. The proximal third duodenum which is contiguous to the tumor shows atypical serrated lower border with marked duodenal lag. These findings are characteristic inflammatory reactions more suggestive of mesenteric adenitis (tuberculous) than of retroperitoneal lesion (renal or pancreatic). The proximal transverse colon shows contour influence of contiguous inflammatory mass. Roentgenoscopically the cecum and ascending colon showed irritability as indicated by spastic peristalsis during barium enema. The distal colon showed delayed motility, however, the cecum and proximal colon very prompt motility. The small intestinal forms showed marked irritation pattern. Operative confirmation: Dr. E. P. Lehman.

In the lower abdomen the displacements of the small intestine, and impressions upon the colonic contour are the most characteristic findings. The outline of the mass is described by the barium-filled intestinal tube. A source of error exists in displace-

Of 15 tumors in the left lower abdomen all but one were of the left adnexa. Fourteen were tumors of the left ovary, 4 carcinomata, 5 simple cysts, one cystadenoma, 3 dermoid cysts, and one abscess involving the ovary. There was usually more or less effect upon the iliac and pelvic colon, depending upon the size of the mass and

the degree of the inflammatory reaction (Figs. 19 and 20).

The only extra-alimentary tumor in the left lower abdominal quadrant, which was not of the left adnexa, was a mass of indurated fat surrounding the sigmoid colon.

In the right lower abdomen, there were 11 tumors, 4 of the ovary and 7 miscellaneous. All of the ovarian tumors were cystomata (Fig. 21). Of the other 7 tumors, one was a large subcutaneous abscess extending from an abscess which filled the right lower abdomen and right pelvis. At operation an adequate exploration was impossible. The abscess appeared to be of perinephritic origin. The displacements in this case were quite similar to those from tumors of the right adnexa, but the clinical manifestations were definitely of an abscess. Another of this group was a mass of tuberculous mesenteric lymph nodes. The roentgen findings determined that the tumor was extra-alimentary and suggested its tuberculous character by the peritoneal reactions (Fig. 22). Another of these tumors of the right lower abdomen was a lymphosarcoma. It was only determined roentgenologically to be extra-alimentary. Another tumor of this group was a retroperitoneal cyst lying between the cecum and the spine. The wall of the cyst was found at operation to be of connective tissue. The cyst contained a brownish yellow fluid which had no cellular content. Two other cases were a large cystic Meckel's diverticulum which was identified at autopsy, and an inflammatory mass of the omentum. The seventh tumor was an error in diagnosis. Nothing was found at exploration of the abdomen (Fig. 23).

Enlargement of the uterus was studied in 22 cases; 7 were instances of the gravid uterus; 4 were carcinoma of the uterus; 10 were fibromyomata, and one was a chronic subinvolution. The intestinal displacements in these cases indicated a low pelvic mass in the midline (Fig. 24). The clinical findings were necessary to determine the nature of the tumor. Calcification of a uterine fibromyoma, when present, is characteristic.

SUMMARY

The gastrointestinal roentgenologic studies which were made in 126 cases of extra-alimentary abdominal tumors have been analyzed for the help given to the diagnosis beyond that of disproving the tumor to be from the alimentary tube. The topographical alterations produced in the tract have usually indicated the intraperitoneal or retroperitoneal position of the mass and given strong presumption as to its origin and in a large percentage of instances have added confirmation to the previous clinical suggestions, or have alone supplied the data which indicated the origin of the mass. These findings together with the clinical data have allowed a high accuracy to the preoperative diagnosis and have also supplied valuable direction to surgical interference. It is believed that these collateral findings to gastrointestinal roentgenology are valuable in abdominal diagnosis and should be emphasized.

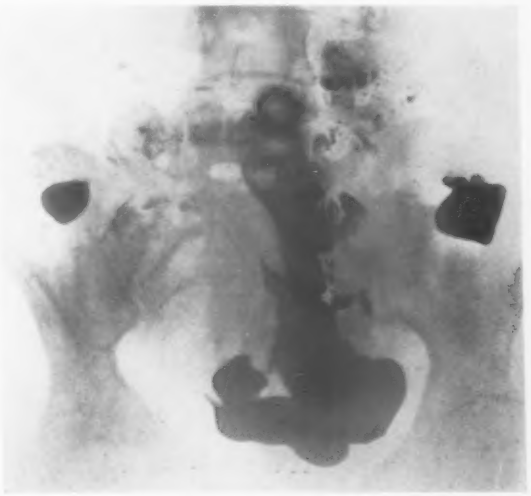

FIG. 23. Roentgenological diagnosis of tumor in right lower abdomen was made but none was found at exploration. There was a suggestion of palpable mass. The small intestine shows striking dislocation with suggested circumferential bounding of a mass.

Operative confirmation: Dr. H. S. Crossen. The appendix was ruptured at the base but there was no definite collection of pus. Fresh adhesions in the pelvis were evidently from appendix inflammation.

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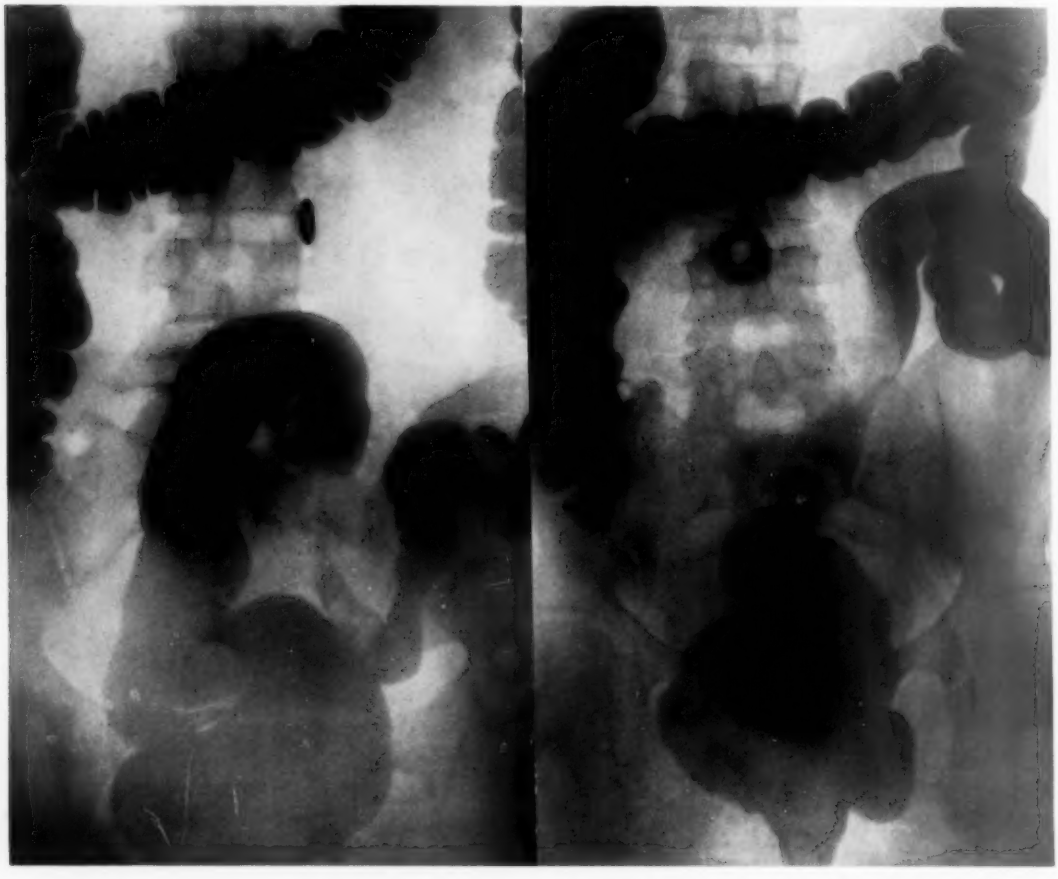

FIG. 24. (Left) Myoma uteri. Upper border of mass palpable above the symphysis pubis. The pelvic colon and proximal rectum show pressure effect of the pelvic tumor. The pelvic colon fills out well roentgenoscopically with change of position. Operative confirmation: Dr. Q. U. Newell. (Right) Myoma uteri with calcification. Upper border of mass palpable in lower abdomen. The sigmoid colon shows pressure effect of mass, and to either side of this segment appear opaque shadows of calcified myoma. The small intestine in both cases was dislocated upward from the pelvis. Operative confirmation: Dr. H. W. Crossen.

Vol. XXVII, No. 3

A HIGH VOLTAGE INDUCTION COIL AND CASCADE TUBE ROENTGEN-RAY OUTFIT*

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1. INTRODUCTION

EARLIER references have been made[1] to an induction coil outfit which was developed for experimental therapeutic use and which is now at the Memorial Hospital in New York City.

The following is a more detailed and up-to-date description.

2. BRIEF DESCRIPTION

The complete outfit, as it was set up in Schenectady, is shown in the photograph of Figure 1 and diagrammatically in Figure 2.

It consists of an oil-filled induction coil and a hot cathode two-section roentgen tube which operates on the pump. As the cathode-ray beam would otherwise be too large, magnetic focussing is employed. To make adequate roentgen-ray protection easier of attainment, the target is placed at the end of a relatively long and narrow cylindrical metal chamber which can be surrounded by a close fitting lead tube of any desired thickness.

The outfit is designed for operation at voltages up to 800,000 or 900,000 and currents of as much as 5 milliamperes.

3. THE INDUCTION COIL

1. The Container. The container consists of the insulating cylindrical tank, *A* (Fig. 2), made by bolting a flat sheet of paper-bakelite to the lower end of a tube of the same material, all joints being made tight by means of cork gaskets and shellac. The tank has an inside diameter of $35\frac{1}{2}$ in., a wall thickness of 5/8 in., and a depth of 60 in.

2. The Core. The core, *K*, is made of sheet silicon steel 0.014 in. thick which has been annealed and varnished. It is 5 in. in diameter and 50 in. long and consists of 316 strips of the various widths required to form a circular cross-section. It weighs approximately 300 pounds. A 3/4 in. hole passing transversely through the center of the core, an inch from the upper end, is provided to facilitate handling by means of a chain hoist. The core strips, bound together with tape, fit tightly in a paper-bakelite tube $5 \times 5\frac{1}{4}$ in. and 50 in. long, on which the primary is wound.

3. The Primary. The primary, *B*, consists of two layers, 40 in. long, of 200 turns each, of rectangular copper strip 0.040 in. thick and 0.110 in. wide, with double cotton covering. For further insulation the adjacent turns of each layer are spaced apart by a cotton cord 0.074 in. in diameter, and the layers are separated by a paper-bakelite tube 1/8 in. thick.

4. The Secondary. The secondary, *E*, consists of 25,200 turns of 0.010 in. copper wire arranged in 138 thin flat coils stacked one above the other, with rings of pressboard between, the whole being clamped together by six bakelite bolts—and two bakelite rings—and having a length of 24 in. The individual coils are 3/32 in. thick and have an inside diameter of 15 in., and an outside diameter of 16 5/8 in. The upper 24 coils are provided with more insulation than the others, because of the surges to which they are subjected, and consist of 100 turns each of quadruple cotton covered wire. The remaining coils consist of 200 turns each of double cotton covered wire.

For convenience of construction and ease of repair, in case of need, the secondary is made up in sections of 6 coils each.

The method of constructing a section may be seen by reference to Figure 3, which

[1] W. D. Coolidge, *Gen. Elect. Rev.* 1930, *33*, 724–725.
W. D. Coolidge, L. E. Dempster, and H. E. Tanis, Jr., *Physics*, 1931, *1*, 230–244.

* Read at the Thirty-second Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 22–25, 1931.

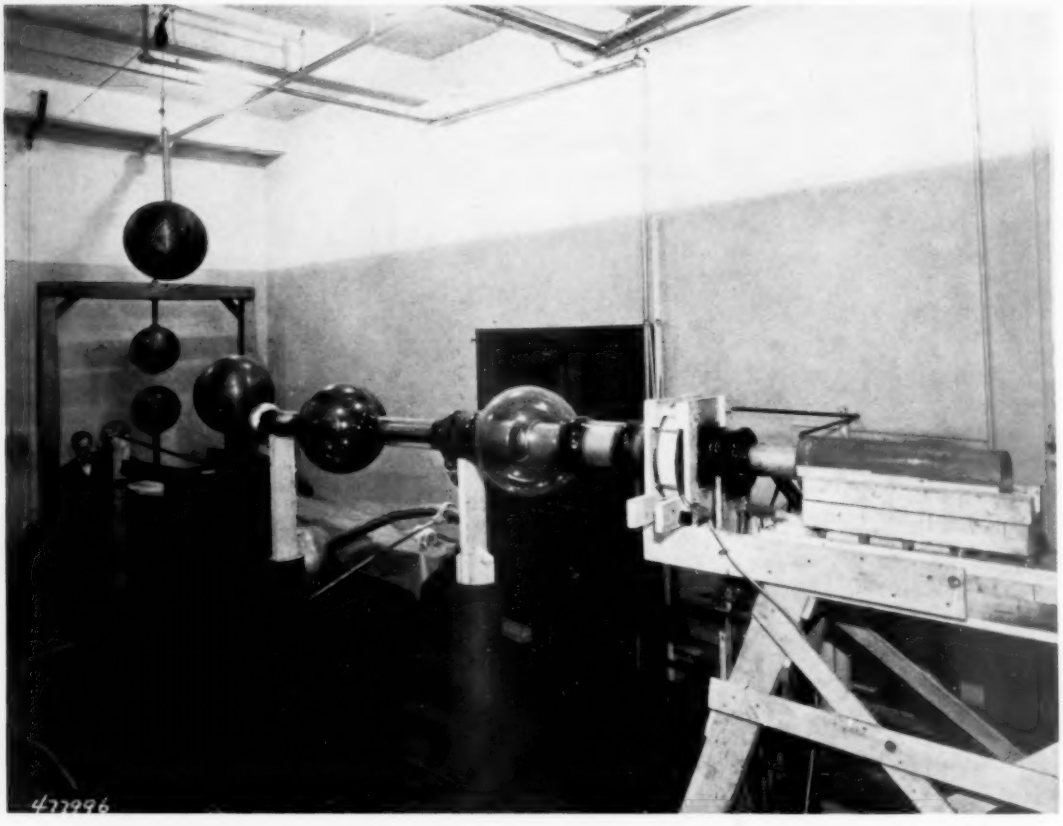

FIG. 1. Two-section roentgen-ray tube with magnetic focussing, operating from induction coil at 900,000 volts and 5 milliamperes.

shows in cross-section the pressboard support rings, *D*, on which the individual coils are wound, and the pressboard spacing rings, *E*, which provide the necessary insulation between coils. For support in the winding lathe, the pressboard rings are clamped between the two steel rings, *A*, by means of 6 bolts, *G*. Metal spacers, *F*, are used to definitely limit the extent to which the paper rings are compressed. The coils are wound in as nearly regular order as is possible without the use of paper between layers. The short wires, *I*, are inserted through holes in the spacing rings before assembly and serve to connect the inner ends of adjacent coils. The winding procedure is as follows: The wire to be used is soldered to the end of *I* in the top coil space, No. 1, and this coil is then wound. The same procedure is followed for Nos. 3 and 5. The remaining three coils are wound in the same manner but in the opposite direction. As the coils are now connected in pairs by their inner ends, it remains only to connect the pairs together by their outer ends, as shown for coils 4 and 5.

The coil assembly is now baked to remove moisture. It is then transferred while hot to a chamber which is first evacuated and then allowed to fill with a suitable varnish, after which air pressure is applied to increase the penetration of the varnish. The assembly is now removed from the vacuum impregnating tank and baked. The varnish solidifies the coils, and sticks coils and pressboard rings together into a solid mass. The metal rings, *A*, are now removed (they were kept from sticking by rings of glassene paper, *B* and *C*) and the section is ready for use. It is first slipped over the primary in oil and tested, and, if satisfactory, takes its place with the other sec-

tions that go to make up the secondary.

5. Assembly. The core and primary and secondary are all held in their proper relative positions by means of a bakelite structure shown in the bottom of the tank in Figure 2, and provision is made for the free circulation of oil between primary and secondary. The core and the lower end of the secondary are grounded.

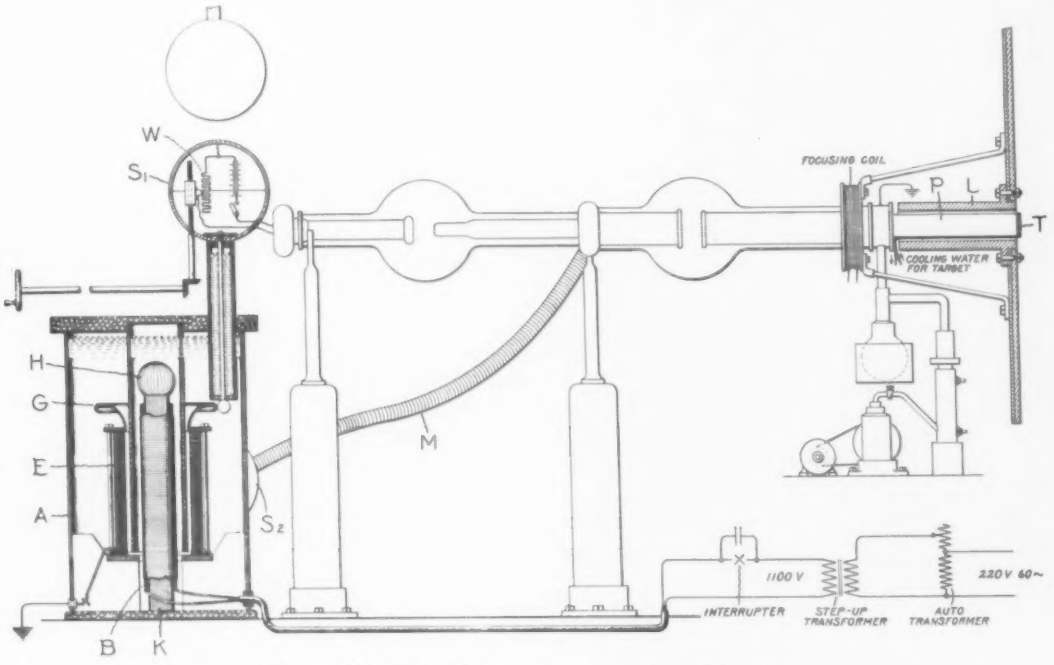

Fig. 2. Diagram of roentgen-ray outfit of Figure 1.

The potential difference between secondary and primary increases as we come up, reaching its maximum at the top of the secondary. With this particular coil, arc-over would take place from the top of the secondary to the primary at about 600,000 volts were it not for the split aluminum spinning, *G*, which electrostatically shields the upper end of the secondary and makes it possible to go to about 800,000 volts. At this point, arc-over would take place from the aluminum spinning to the upper end of the core were it not for the spherical shield, *H*, which makes it possible to go up to 900,000 volts. The design of this latter shield is important, as it has to be electrically conducting and is located where nearly all of the magnetic flux of the core passes through it. If it were a hollow metal sphere of appreciable thickness, most of the energy delivered to the primary would be wasted in the sphere in eddy currents. The construction indicated has been found satisfactory and consists of a wooden sphere overlaid with narrow strips of sheet aluminum placed as shown, and metallically joined at the top to the upper end of the core.

To increase the insulation between primary and secondary, a paper-bakelite tube

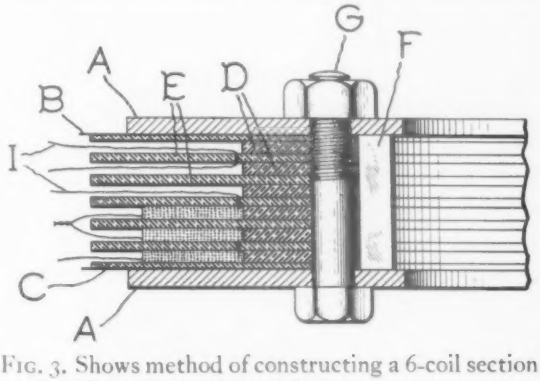

Fig. 3. Shows method of constructing a 6-coil section of the induction coil secondary.

is used as a barrier and spaced midway between them.

The 900,000 volt lead passes up through an oil bushing to a 20 in. hollow metal sphere S_1, which serves as a container for the storage battery, used to light the filament, and the remote controlled adjustable rheostat, W, and, at the same time, as a terminal of the measuring sphere-gap.

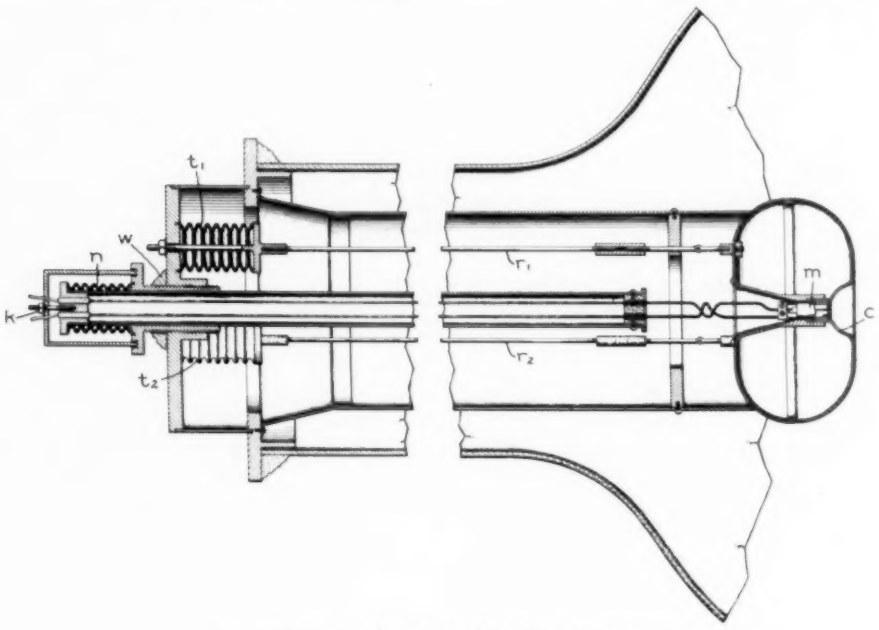

FIG. 4. Details of adjustable cathode structure.

To secure the required potential for the intermediate electrode of a two-section tube, conductor M and sphere S_2 are connected to the middle of the secondary.

6. Operation. The coil is operated from 1,100 volt 60 cycle current derived from a step-up transformer which, for voltage control, is fed from an autotransformer with suitable taps and selector switch.

The interrupter is of the hydrogen-filled mercury-turbine type, driven by a synchronous motor, which is so adjusted that the primary circuit is closed when the voltage is low and opened shortly after reaching the peak of the voltage wave. The synchronous motor has 4 poles and the coil therefore produces 60 current impulses per second.

Secondary voltage is measured by means of a spark-gap consisting of an overhead grounded sphere and the terminal sphere of the coil. As this gap does not comply fully with standard specifications, it has been checked against the standard gap shown in the background of Figure 1.

7. Advantages of the Induction Coil. For high voltages, and currents of not more than a few milliamperes, the induction coil gives such an unsymmetrical wave that, even with a considerable load, the "useful" voltage is higher than the "inverse."

For the operation of a tube carrying current in only one direction, this is a decided advantage, as it permits of utilization of the maximum voltage produced. If, on the contrary, the no-load wave-form were symmetrical, the inverse voltage would be higher than the useful by an amount increasing with the load, thus putting a useless strain on both the high voltage source and the tube and so necessitating a larger outfit. A contingent advantage in having the "useful" voltage higher than the inverse consists in the fact that it simplifies the measurement of "useful" voltage, making it possible to do this by applying the sphere-gap directly to the tube terminals.

The wave-form of the induction coil also permits of the attainment of a given voltage with less insulation than would be required with a sine wave.

The high magnetic leakage, inherent in the open core, tends to diminish the electrical and fire hazards; it also makes it unnecessary to use resistances in series with the measuring sphere-gap.

Relatively speaking, the induction coil is of small bulk, simple, and inexpensive.

4. THE ROENTGEN-RAY TUBE

1. The Glass Envelope. The roentgen tube is made of two sections, each of which consists of a 20 in. bulb, having a wall thickness of about 1/4 in., and cylindrical arms having an external diameter of 6 in. in the first section (left hand in Figure 2), and $8\frac{3}{4}$ in. in the second section. The cathode arm is, in each case, made shorter than the anode arm. Wax joints are used throughout.

2. The Cathode. It would be difficult to construct a cascade tube as long as that shown in Figures 1 and 2 so accurately that without adjustment the cathode-ray beam would be central with respect to the axis of the tube throughout its length. We have

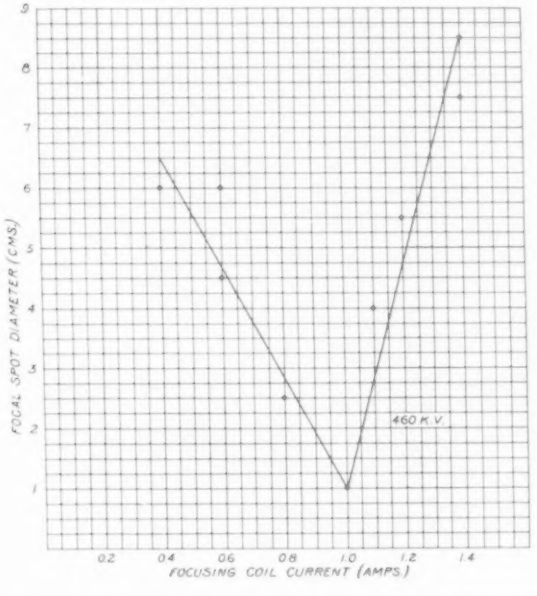

FIG. 5. Graph showing dependence of focal-spot size upon current in magnetic focussing coil.

therefore found it desirable to make the electrostatic focussing member of the cathode in the first section adjustable. It is supported, as shown in Figure 4, by three

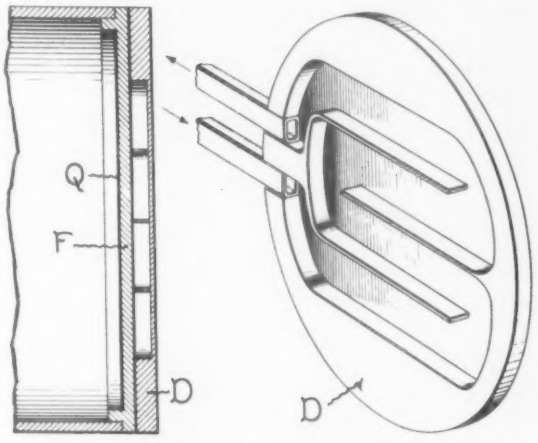

FIG. 6. Shows target construction.

metal rods, two of which, r_1, r_2, are shown, each of which rods can be moved without breaking the vacuum, through the help of three small sylphon tubes, two of which, t_1 and t_2, are shown. The required adjustment is quickly made by operating the tube while observing a fluorescent screen wrapped around the metal extension chamber at the anode end, or it can be made with magnetic focussing, by the help of a roentgen-ray pin-hole camera directed at the target.

With proper adjustment of this electrostatic focussing member, none of the beam strikes the intermediate electrode, as is shown by the fact that a milliammeter in series with it indicates no current and that milliammeters placed in circuit at the two ends of the tube read alike.

The cathode filament is rigidly mounted in a molybdenum cylinder, *m*, which fits loosely in the surrounding copper structure. To permit of adjustment of the setting of the filament relative to the focussing cup, *c*, without breaking the vacuum, use is made of the sylphon tube, *n*, and the nut, *k*. For replacement of a filament, the entire filament assembly may be removed by letting air into the tube and heating the wax at *w*.

3. Magnetic Focussing. Magnetic focus-

sing is used to control the size of the cathode-ray beam at the target. The reason for this is as follows: With a cathode designed to provide as much as several milliamperes of current, the cathode-ray beam is divergent after entering the first intermediate electrode. In passing through the electrostatic field between the electrodes of the second section the divergence is reduced, but still upon reaching the end of the anode arm the beam is about 10 centimeters in diameter.

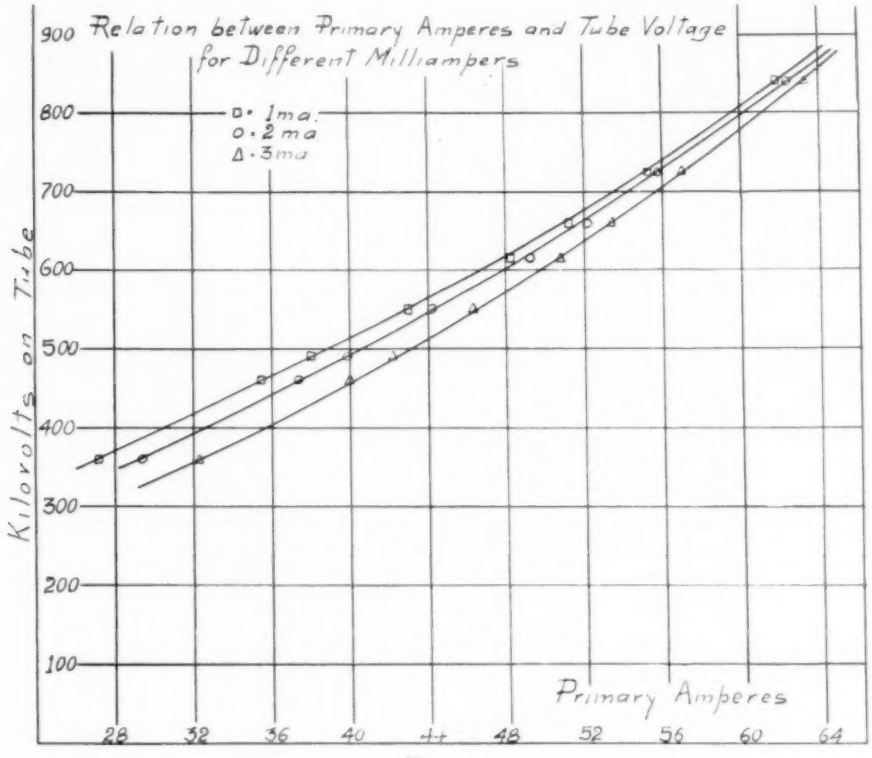

FIG. 7.

Magnetic focussing could be applied between sections, but it has been found much more satisfactory to apply it at the anode end of the tube, as shown in Figures 1 and 2. The target, *T*, is located at the end of a metal extension tube which is about 2 feet long, and, to produce a focal spot 1 cm. in diameter, a current of about 1 ampere is required in the 4000 turn focussing coil.

The theory of magnetic focussing for flat coils has been developed by Busch.[2] Our experience indicates that the theory holds very closely for the conditions pertaining in the present two-section tube. At 460 kv. the relation of focal spot size to the current used in the focussing coil is shown by the graph of Figure 5. As tube voltage is raised, the current required in the focussing coil for a given size of focal spot increases. For example, on going from 460 kv. to 700 kv., the current required for the minimum size of focal spot went from 1.0 up to 1.1 amperes.

If much energy is to be employed, there is a very real hazard in having the focal spot size manually adjustable, as it makes it easy to so overload the focal spot as to ruin the target. This is especially true in the case of thin targets. The hazard can be eliminated by always working with less focussing current than that required for sharpest focussing and using a fixed current-limiting resistance in series with the focussing coil. This resistance should have such a value that, with the lowest tube

[2] Busch, H., *Ann. d. phys.*, 1926, *81*, 974–993.

voltage which is to be employed and with the highest voltage assumed by the line supplying direct current to the focussing coil, the focal spot size is adequate. Then as the focussing current decreases with decreasing line voltage, the focal spot increases in size—a change in the direction of safety. Similarly as tube voltage is raised and with it the energy delivered to the target (assuming that tube milliamperage is kept constant), the focal spot size increases as it should.

5. Roentgen-ray Protection. Roentgen rays are taken out through the target. Protection from most of the roentgen rays going in the opposite direction is secured by means of the lead cylinder, *L* (Fig. 2).

To reduce the roentgen-ray production due to electrons coming away from the focal spot, the brass tube, *P*, is lined with aluminum. The tube, *P*, is made as long and as narrow as it is, to reduce the escape of roentgen radiation in the backward direction.

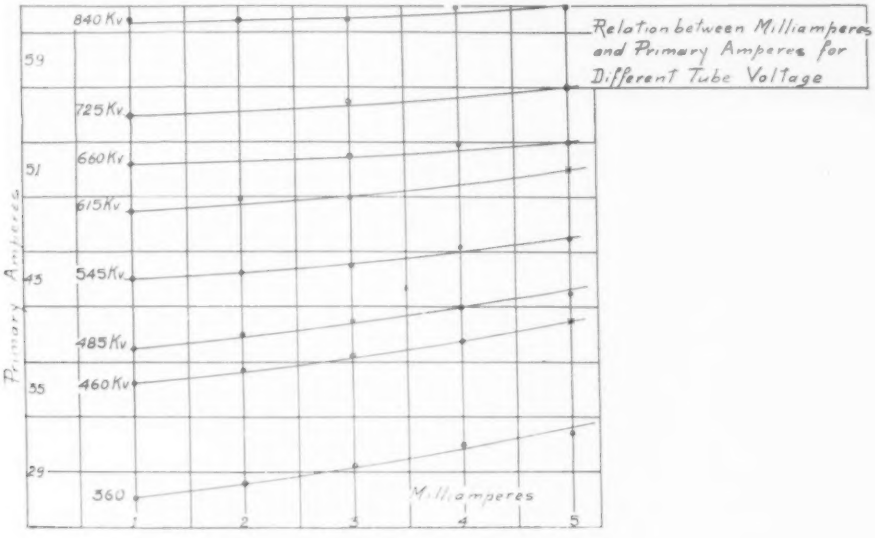

Fig. 8.

4. The Target. The target, *T*, shown in section in Figure 6, consists of a tungsten face, *Q*, only thick enough to stop 900,000 volt electrons (0.15 mm.—calculated from the measured range in air), onto which has been cast a layer of copper, *F*, 3 mm. thick. Soldered to the back of the copper plate is a brass chamber, *D*, through which cooling water is circulated. The roentgen rays have to pass through 3 mm. of copper, 3.7 mm. of water, and 1 mm. of brass.

It is of course not necessary to take the roentgen rays out through the target; they could just as well, and for many purposes, better, be taken out from the face of the ordinary thick target, in a direction at right angles to the tube axis.

6. The Exhaust System. This consists of a "Megavac" oil pump, a metal condensation pump, and a liquid air trap.

During operation, water vapor and carbon dioxide from the tube walls and the electrodes condense in the liquid air trap and are held there as long as liquid air is maintained around the trap. If the liquid air supply is ever allowed to become exhausted, however, this water vapor and carbon dioxide diffuse back into the tube and again condense on the walls and electrodes, where their presence causes a considerable delay on subsequent operation.

5. Electrical Characteristics

Some of the electrical characteristics of the outfit are shown by the graphs of Fig-

ures 7, 8, and 9. For these, and for the data on which they are based, we are indebted to Dr. Failla.

Figures 7 and 8 give the relation between primary current, tube voltage and milliamperage.

Figure 9 shows the simple relationship existing between primary voltage and secondary voltage—a relationship which is independent of milliamperage over the range from 1 to 5 milliamperes.

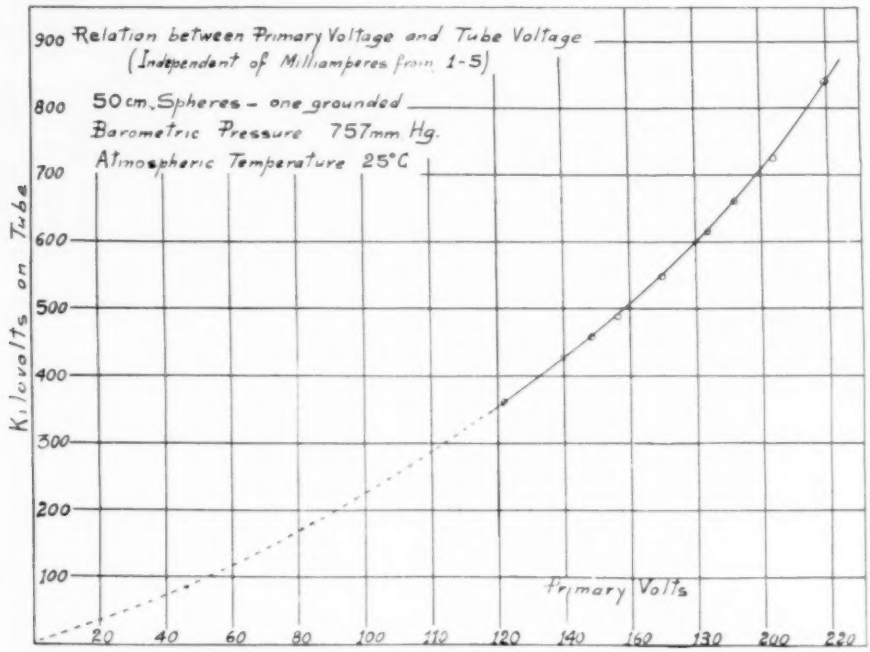

FIG. 9.

The shape of these graphs and the precision attained seem to indicate that such an induction coil outfit lends itself very satisfactorily to quantitative work.

That the roentgen-ray output is quite regular is shown by Figure 10, taken from a roentgenogram of a stationary slit made on a rotating film, in which each white line corresponds to a single impulse through the tube. This was with 5 ma. and 800 kv.

Figure 11 shows some absorption curves for lead, made by Dr. Failla. The curve for 200 kv. was obtained with an ordinary 200 kv. tube and a transformer outfit, while those for higher voltages were obtained with the big tube and the induction coil outfit. For the curve marked "700 kv.+ 6 mm. Pb" a 6 mm. lead filter was used next to the tube. The topmost curve was for gamma rays from radium.

To determine the wave form of the coil with its roentgen-ray tube load, it will be necessary to use a cathode-ray oscillograph, and a study of this kind will be undertaken on a similar coil.

The important question of how the roentgen-ray output per ma., and how the maximum attainable ratio of depth dose to skin dose from such a coil will compare with those from other high voltage sources, must await further measurements.

6. CONCLUSION

In closing, we wish to point out that there are other interesting sources of high voltage for roentgen-ray work. To mention a few of these:

A simple chain-connected transformer for a million volts has been put in very compact form by Mr. Hendricks of Pittsfield.

There are now available direct current constant potential outfits producing 100,-

000 volts per unit; and any desired voltage may be obtained by putting the required number of these units in series.

Dr. Van de Graaff, of Princeton, is doing some very interesting work on the static machine—work which promises to yield exceedingly high voltages.

At the same time that work is being carried out on the development of high voltage sources, Dr. Lawrence, of Berkeley, is doing beautiful work on methods for getting high energy particles without the necessity of going to high voltages.

In short, there is much interest in this field, and it seems certain that, as a result of it all, the roentgenologist will have some day an adequate supply of very short wavelength roentgen radiation—shorter even, perhaps, than that of the gamma rays.

We have intentionally not touched upon the question of the therapeutic value of such radiation, as that is the problem of the medical profession, not that of the physicist.

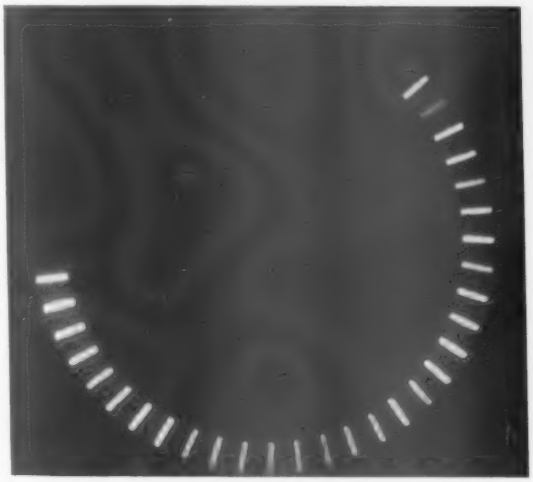

Fig. 10. Roentgenogram of stationary slit, made on rotating film, with 5 ma. and 800 kv.

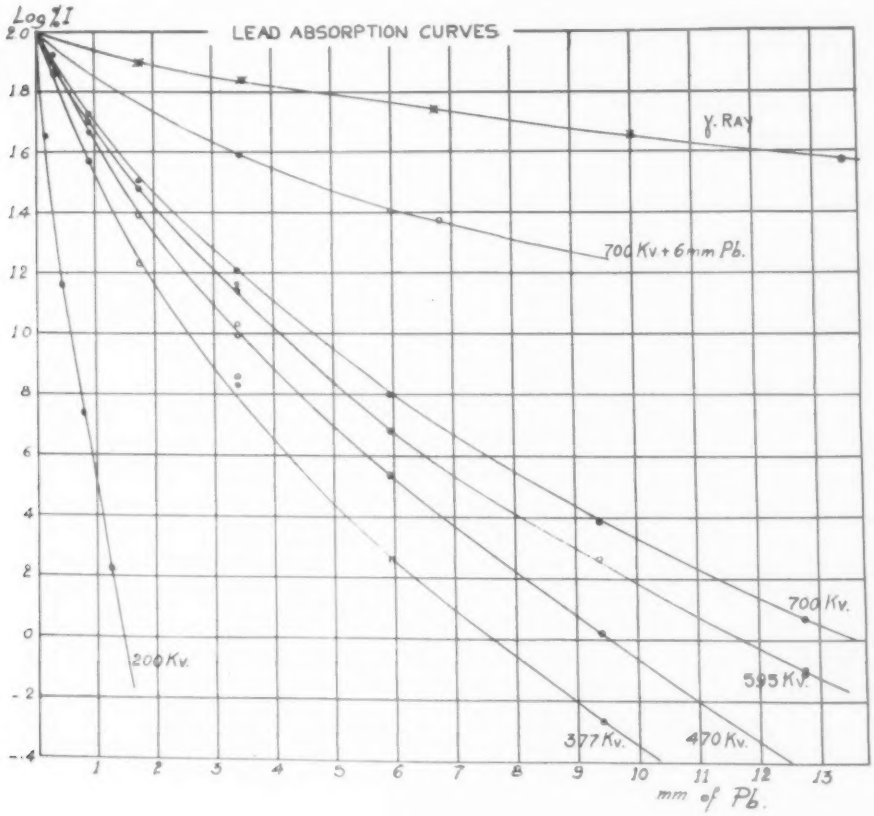

Fig. 11.

DISCUSSION

Dr. G. Failla, New York City. Referring to Dr. Coolidge's paper, I may say that the tube described by him is working very well in actual practice. It can be run continuously for one hour or longer at 700 kv. and 5 ma. It requires no special attention aside from checking the degree of vacuum before starting and occasionally while in operation. It is not necessary to raise the applied voltage gradually. If the vacuum gauge shows the proper degree of vacuum the full voltage may be applied to the tube without danger. If gas is produced during operation it is only necessary to stop for a few minutes and the vacuum pump will exhaust the tube to the proper degree. We have had no punctures, but if one should occur it is a simple matter to seal it with cement. Accordingly the tube life is not dependent on accumulation of gas or punctures.

As you all know, Dr. Coolidge announced a year ago that the tube was to be installed at the Memorial Hospital. The actual installation, however, was not made until last June. In the meantime I heard considerable discussion about the operation of this tube and its practical utility. In these discussions there was often a note of skepticism. Some predicted that the tube would not work because the distance between the cathode and the target was too great (about 10 feet) and the cathode rays would not reach the target. Some predicted that the induction coil would give a great deal of trouble. I must admit that I expected some trouble myself from this source. In fact, I was surprised to see how satisfactory this induction coil is as a source of high potential. The whole outfit runs very smoothly and the milliammeter shows no greater fluctuations than in the case of the usual roentgen machine operated at 200 kv. The third pessimistic prediction which has been made is that the tube is of no practical value because biological effects are independent of wave length and there is no need in therapeutic work for such high voltages. I can say nothing about this today except that we are carrying out experimental work which will eventually settle this question.

THERAPEUTIC ABORTION PRODUCED BY THE ROENTGEN RAY*

By WILLIAM HARRIS, M.D.
NEW YORK CITY

THERAPEUTIC abortion as produced by roentgen rays may be considered as an additional step towards conservatism in the field of gynecology. This procedure may also be regarded as having a profound bearing upon certain problems in social and preventive medicine.

Fränkel[2] in 1907 was the first to describe therapeutic abortion produced by roentgen irradiation. Many reports of success or failure soon followed. In 1925 Ganzoni and Widmer[4] reported the first large series of pregnancies terminated by roentgen irradiation. They reported 34 cases, with success in 29. The failures occurred in the early part of their series and were attributed to faulty technique.

A preliminary report describing the first 22 cases treated in Mount Sinai Hospital was published by Wyser and Mayer.[8] A second report was made by the late Dr. Samuel Stern[6] upon 12 additional cases. The present report comprises 138 cases including the former series.

INDICATIONS AND CHOICE OF METHOD

The indications for therapeutic abortion necessarily belong to the realm of general medicine. Primarily, therapeutic abortion is indicated when the pregnancy is an immediate or ultimate menace to the life of the patient. Therapeutic abortion by surgery has a definite mortality and morbidity, especially in patients who are suffering from organic disease. Ziwatoff[9] reported a large series of cases where no organic disease was present and where induced abortion by surgery in patients who were over three months gravid resulted in 3.6 per cent mortality. It is in those cases where therapeutic abortion is indicated and where surgical intervention is dangerous, that the roentgen-ray method is indicated.

In choosing roentgen irradiation as the method of terminating a pregnancy, a number of factors must be kept in mind. Primarily, it should be reserved for patients in whom further pregnancies are contraindicated. However, it may be mentioned in passing, that the danger of gravidity, resulting in a monstrosity following the temporary amenorrhea produced by roentgen rays is still a moot question. Inasmuch as the final word has not been said on this subject, we feel that this method should not be used where a gravidity might be desired at some later time.

It is important, when this method of terminating a pregnancy is used, to realize that a period of amenorrhea will follow, especially if the ovaries are included in the irradiated field. This period of amenorrhea will usually be permanent in patients approaching the menopause, but it will last for about two years in women under thirty-five. The amenorrhea is accompanied by the usual climacteric phenomena, such as flushes, sweating, joint pains, paresthesia, etc. This can be avoided in a certain number if the ovaries are partly shielded. In such an instance the sterilizing effect is lost. In 4 cases, not included in this series, where this was done, menstruation occurred regularly after the abortion. In the majority of cases sterilization as well as abortion is desired and the question arises whether the younger patients, in whom the menses usually return in two years, should receive later treatment for the production of permanent amenorrhea and sterility. It must be remembered, however, that amenorrhea produced by roentgen irradiation does not necessarily mean sterility. We have had several instances where pregnancy occurred during the amenorrheic period in patients treated for fibromyoma of the uterus;

* From the Radiotherapy and Gynecological Departments of the Mount Sinai Hospital, New York City.

this has also been experienced by others. It is because of this possibility that our patients are taught contraceptive methods. In most instances, however, this precaution is unnecessary during the amenorrheic period. Four patients in this series became pregnant after roentgen abortion. They were successfully aborted the second time by roentgen irradiation.

CHOICE OF CASES

We have now limited ourselves to the patients pregnant for a period not exceeding eighteen weeks. In order to learn the limitations of this method and because it was felt by one of our predecessors that older gravidities would respond,[6] a patient who was five and a half months gravid and who had severe cardio-nephritis, was treated to determine this question. This patient was followed for four weeks, during which time there was continued growth of the fetus. It was deemed inadvisable to wait longer and labor was induced in this patient by the introduction of a Voorhees bag. We therefore feel that patients who are over eighteen weeks gravid should not be treated by this method. In fact, we feel that it may be safer as a general rule to limit this method to patients who are not over sixteen weeks gravid.

It is not my intention to deal at length with the indications for the termination of pregnancy; however, I should like to present some of the conditions in which the roentgen method was found to be particularly useful.

1. *Active Tuberculosis.* It has been found that the tuberculous patient is doubly benefited: first, by the production of the abortion; second, by the period of amenorrhea which follows the therapy. The amenorrhea is of special benefit to those patients who have hemoptysis during the menses.

2. *Cardiorenal Disease.* In this group, surgery is especially dangerous even though local anesthesia is used. The danger of infection, thrombosis, or decompensation is considerable. Pelvic complications are very dangerous in this type of case. Study of the products of conception after roentgen abortion points toward a closure of the maternal-placental circulation which is of distinct value in this group.

3. *Epilepsy.* The inherited character of this condition makes abortion desirable, and in one case where the patient was sterilized as well as aborted, the number of seizures while the patient was amenorrheic were definitely diminished.

4. *Malignant Growths.* The untoward effect of pregnancy upon most malignant growths is generally known. We feel that the roentgen method of producing abortion in these cases is very valuable.

5. *In severe diabetes*, not responding to insulin therapy, especially in patients approaching the menopause.

6. *Toxic goiters*, especially in cases where marked cardiac damage has occurred.

7. *Psychopathics* and *mental defectives.*

8. *Deforming Arthritis.* Three patients of this series had ankylosis of both hips making vaginal examination very difficult. Surgical induction of abortion via the vagina would have been impossible.

It may be stated here that in the follow-up of our cases, no untoward sequelae were found that could be attributed to the roentgen method of abortion.

COURSE FOLLOWING TREATMENT

Of the 138 cases here reported, abortion was successfully produced in 129. The age of the patients varied from nineteen to forty-three years. The duration of the pregnancy was from six to sixteen weeks with the one exception, namely, the patient who was gravid twenty-two weeks and who was treated unsuccessfully. The interval between treatment and spontaneous abortion averaged about four weeks. In one case 128 days elapsed after the treatment before the fetus was expelled. In 43 cases the entire ovular sac and fetus were expelled intact. There were varying intervals between expulsion of the fetus and placenta in 45 patients. The interval between the expulsion of the fetus and placenta in those cases

that were not expelled intact, was between several hours and five days. Removal of the placenta presenting in the cervix was performed with an ovum forceps in 3 cases. There were no instances of definitely retained adherent placenta. The average hospitalization was six days. The uterine contents behaves like a missed abortion which is expelled spontaneously.

FAILURES

The gravid uterus was emptied surgically in 3 patients in the early part of this series. The macerated fetuses would undoubtedly have been expelled had we waited. However, these were included as failures. Five cases in which the uterus was emptied surgically were definitely underdosed. One of these was a very obese patient in whom there was difficulty in mapping out the size of the uterus. The ninth failure was the patient who was five and a half months pregnant. As our experience increases we feel that these errors will be avoided.

TECHNIQUE

The technique used in this series of cases was fairly uniform. The patient is given a mild cathartic on the night before treatment and an enema in the morning. A light breakfast is allowed in some cases. The bladder is always emptied before treatment. A drawing is made of the outline of the pelvis and a vaginal examination is done to determine the outline of the fundus and to note its size and position. In some cases there will be a discrepency between the size of the uterus and the length of amenorrhea. This may be due to the presence of fibroids which have not been found to be a contraindication to treatment by the roentgen irradiation; on the contrary, these are desirable cases that lend themselves to this therapy.

The calculation of the number of fields and other factors is then done according to the method of Holfelder[5] or Weatherwax et al.[7] Our aim is to get 60 per cent of a skin erythema dose (510 r)* into the fundus of the uterus. Usually two fields, one anterior and one posterior, which include the ovaries, will suffice. However, one patient required six fields on account of her obesity. Our dosage is so calculated that a definite erythema of the skin may be avoided. We try to avoid giving over 90 per cent S.E.D. to any field, but we have found that even 85 per cent may give a moderate transient dermatitis in some cases. In this connection we may note that the skin of pregnant women appears to be hypersensitive to roentgen rays. In using this method it is of utmost importance to work with an apparatus which has been standardized by a competent physicist and the depth dose of which is definitely known. This cannot be emphasized too strongly. We use 200 kv. with a filter of 0.5 mm. copper and 1 mm. aluminum. The treatments are usually given on two successive days.

* 850 r (International unit) (including back scattering from the patient) represents an erythema dose.

FOLLOW-UP

Weekly examinations are made after the treatment has been given, and changes in the size of the uterus are noted. This is not always possible in obese patients, but where it has been found possible to map out the fundus we have noted that growth stops about two to three weeks after treatment. The test for the determination of female sex hormone in the general circulation as described by Frank[1] and his coworkers has been used to ascertain the viability or death of the fetus. Normally the female sex hormone is found, after the sixth to eighth week of pregnancy, in the venous blood. In several cases of this series where this test was made, the hormone was absent from the general circulation about two weeks after treatment. This test has been of inestimable value in checking up the question of viability of the fetus in doubtful cases. We have had several definite instances where the test for female sex hormone remained positive after treatment and where the fetus was found alive when expelled. It was also found in several doubtful cases, where the test proved negative, that the fetus was dead. If facilities for utilizing

this test are not available, use may be made of the Ascheim-Zondek[10] test for the determination of viability of the fetus, although this test may remain positive weeks after fetal death has occurred.

The successful outcome in a case which at first seemed to be a failure may be illustrated by the following history:

The patient was seven weeks gravid when she received roentgen treatment. During our weekly follow-up, we found that the uterus continued to grow. Seven weeks later when there was no doubt as to the viability of the fetus, a second series of roentgen therapy was given, with a successful termination of the pregnancy three weeks later. Upon going over the details of the treatment it was found that too small a dose was given to the fundus of the uterus.

ABORTION

When bleeding begins, the patient is put to bed and treated as an ordinary abortion. The pain is seldom severe. Occasionally a mild sedative may be indicated. The course is usually afebrile. In one case with the retained placenta, the fever readily subsided when the retained products were removed from the gaping cervix. No major surgical procedure has been required except in our failures where labor was induced by a Voorhees bag or a bougie. We have never seen a pelvic or organic complication, nor has there been long hospitalization.

MECHANISM OF ABORTION

In discussing the mechanism of abortion produced by roentgen therapy, three factors must be considered: the ovaries, the fetus and the placenta. We know that changes must occur in the ovaries if they are included in the irradiated field, but the fact that the abortion can be produced by shielding them and the fact that ovaries containing the corpus luteum of pregnancy can be removed surgically after the eighth week of gravidity without producing abortion, would seem to minimize the rôle that the ovaries play in producing abortion by the roentgen method.

The destructive action of roentgen rays on the fetus or placenta, or both, must underlie the cause for the termination of the pregnancy. Friedrich[3] in 1910 reported a case which failed to abort following the use of roentgen radiation. A hysterotomy was done and the fetus immediately examined. Marked changes were found in the spleen of the fetus especially in its lymphoid apparatus. There was pycnosis of the cell nuclei, granular pigment distributed throughout the organ and a marked diminution of white blood corpuscles in the blood vessels. The kidneys and liver showed similar changes. These findings were compared with two fetuses of the same age which had not been irradiated, and where no pathological changes were found. Studies have been made in our laboratory upon the expelled products of conception. Grossly there is definite maceration of the ovum. The placental attachment has a less shaggy and more fibrotic appearance than normal. Microscopic studies of the placenta have given us little information because of the post-mortem changes and because one normally finds areas of degeneration in so-called normal placentae. In our fifth failure where surgical intervention was used, the fetus lived three days. A post-mortem examination was made and a cyst of the brain was found. This might have been due to roentgen irradiation. It must be definitely remembered therefore if failure occurs by this method, and if it has advanced beyond sixteen weeks, the pregnancy must be terminated surgically because of the great likelihood of malformation of the fetus. If failure is ascertained before the sixteenth week the treatment can be repeated. The likelihood of malformation is of course much greater in a patient who is pregnant at the time of irradiation than in one whose pelvis has been irradiated at some time before conception and whose ovarian follicular apparatus may have been injured.

CONCLUSIONS

1. Therapeutic abortion produced by roentgen irradiation offers a method without mortality or morbidity for ending a pregnancy in cases where surgical inter-

vention is contraindicated and where future pregnancy cannot be countenanced because of serious and permanent systemic disease.

2. The sterilizing effect of this form of treatment is of special benefit to patients suffering from chronic disease.

3. Partial shielding of the ovaries will prevent amenorrhea in some cases.

4. One hundred and thirty-eight patients were treated, with complete success in 129. Three of the 6 failures showed dead fetuses which undoubtedly would have been expelled had we waited. We have had 4 failures in the last 106 cases.

5. The dosage is 60 per cent S.E.D. into the gravid uterus.

6. The roentgen apparatus must be accurately calibrated, especially for depth dose.

7. There is usually no danger in waiting for expulsion of the fetus if the uterus has stopped growing and if there are no signs of toxic absorption.

8. If failure is discovered before the pregnancy has advanced to sixteen weeks the treatment may be repeated.

9. If the patient becomes pregnant again at some later date, a second roentgen abortion should be done.

10. The average interval between treatment and expulsion of fetus is four weeks.

11. The exact mechanism underlying the death of the fetus is not entirely clear.

12. This procedure, when undertaken, must have close cooperation between the gynecologist and radiotherapist.

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VOLVULUS OF THE STOMACH

REPORT OF TWO CASES

By PROF. S. AZMY *and* DR. AHMED MAREY
Egyptian University, Kas-El-Aini Hospital
CAIRO, EGYPT

CASE I. Male, aged forty-nine, of medium weight; shows puffiness of the eyes; complains of occasional breathlessness on exertion, a sense of discomfort amounting to dizziness

FIG. 1

after food and sometimes hunger pains. Blood examination shows slight increase of urea, while the urine shows decrease of urea and presence of albumin. Heart shows moderate enlargement and a slight increase of blood pressure (170 mm.)

For the last two years he was treated as a case of chronic nephritis; however, when he was referred to us, on account of predominating gastric symptoms, he was recommended for roentgen examination of the stomach, which revealed the following:

No evidence of hypersecretion was found and no tenderness on pressure could be elicited in the stomach region. The stomach was of cascade form, which was well marked on screening in the lateral view, and the stomach was seen divided into two parts which were connected by a small narrow canal. On filling the whole of the stomach with the meal, however, it was found to be an extreme form of cascade stomach, in which there was complete torsion, or rather volvulus, on its long axis with fixation of the uppermost part of the pars cardiaca (fundus), so that the whole of the great curvature was displaced upwards, the lesser curvature downwards, the posterior wall was seen in front and the anterior wall behind (including the duodenum) (Fig. 1).

The stomach was situated high up under the costal arch in an oblique or almost transverse position and a good deal to the right side. On account of its high position up under the costal arch, free palpation was rendered difficult but apparently it possessed fairly good mobility. It was of normal size and showed regular, smooth contour, with rather frequent, fairly intense peristaltic contractions, and after three and a half hours there was complete evacuation of the meal.

Duodenum: The bulb lay high up opposite the twelfth dorsal and shared in the upside down displacement. It was easily filled, quickly emptied and showed perfectly regular contour and no tenderness on pressure.

CASE II. Male, aged forty-five, complained of pain in the epigastrium, especially marked in the region of the gall-bladder, which although it could not be felt showed tenderness on pressure, with resistance and slight rigidity of the right rectus muscle. Suffers from pain two or three hours after food, radiating to the back, hunger pain, and sometimes nausea but no vomiting.

Examination of blood revealed positive Wassermann reaction. Chest and heart normal. Roentgen examination of the gall-bladder showed no stones, with normal filling, concentration and emptying function. The roentgen examination of the stomach showed exactly the same findings as in the first case, while the duodenum showed evidence of a chronic ulcer, with deformity and adhesions at its greater curvature.

CONCLUSIONS

Unfortunately, repeated roentgen examination of the stomach and further examination of the intestine, fractional test meal and diet test were all refused by both

patients. However, we are of the opinion that this extreme form of cascade stomach, which amounts to its complete torsion or volvulus, could only be produced by a long-standing, excessive, gaseous distention of the transverse colon, which during its ascent carries away with it forwards and upwards the greater curvature, to which it is connected by the gastrocolic omentum. The stomach is thus twisted upon its longitudinal axis and as the greater curvature is carried upwards, the stomach is more or less turned on itself and in its extreme degree the posterior surface gets in front and the anterior behind, the greater curvature upwards and the lesser downwards (see Fig. 1), thus producing a total volvulus of the stomach. However, repeated examination of the stomach after the colon is empty, combined with the enema examination of the large bowel, would have been necessary to ascertain whether this rare deformity was variable or constant.

Neither of the two patients has developed other symptoms since the last roentgen examination carried out a year ago.

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EDITORIAL

JOANNES BAPTISTA BIANCHUS, REDIVIVUS

(BEING AN ACCOUNT OF THE MANNER OF THE EFFLUX AND INFLUX OF BILE[1])

IT IS characteristic of the history of medicine that each new advance in a difficult field is followed by sporadic returns to older theories, often presented as novel. Thus it happens that the close of a decade of significant work on the gall-bladder, starting with the fundamental researches of Rous and McMaster,[2] has witnessed the revival of a 17th century theory of the evacuation of cystic bile.

As presented by Bianchus in the 18th century, this theory was a naïve exposition, unembarrassed by the necessity of using modern technical methods and carrying a germ of truth—namely, that somehow the food we eat has a direct influence on the expulsion of bile.

> Truly [says Bianchus], because the fundus of the stomach is expanded more or less, according to the abundance of the ingesta, so the gall bladder, compressed more or less from the greater or smaller enlarging of the stomach, emits a greater or smaller abundance of its liquid into the intestine; thus the degree of pressure on the gall bladder is proportional to the degree of swelling of the stomach; and so, according to the quantity of the food mass to be dissolved, a proportionate quantity of bile fitly descends into the duodenum, to bestow upon it the services owed it.

In this theory, as in its modern rejuvenated forms, no consideration is given to the diverse action of different foods, now a corner-stone of roentgenologic practice. Yet, is it logical for the modern successors of Bianchus to advocate that the steady diminution of volume of the human gall-bladder—after a meal of egg yolk,[3] or following the injection of hydragogue cathartics[4]—is due to mechanical pressure of adjacent viscera, when equal quantities of egg white or rice have little effect on cystic volume?[5,9] Or is it likely that an organ, which in lower vertebrates exhibits active peristalsis[6] after a meal of egg yolk, should lose all power of muscular contraction in higher vertebrates? Or how, on a mechanical basis, can one account for evacuation of cystic bile, following intravenous injection of extracts of the intestinal mucosa,[7] or for reflex inhibition of a discharging gall-bladder following faradic stimulation of any part of the gut tract?[8]

Surely, Bianchus could not have foreseen these complications, nor the fact that the gall-bladder would empty even faster when egg yolk is introduced by tube into the duodenum.[3] With the stomach thus eliminated, he would have had to consider pressure of food in the duodenal cap, the only part of the small intestine in contact with the gall-bladder. But had he injected a small amount of water into the duodenum and, after half an hour, an equal amount

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of egg yolk, he would have found that twice as much bile was expelled the second time as the first.[9] Then there would have remained to him but one mechanical device—pressure from peristalsis of the duodenal cap. In this contention he would have been safe, for there were no roentgenologists to tell him that this is the least active part of the duodenum, where the barium lingers longest and the muscle is least developed.[10] Nor would he have known that egg yolk, when injected into the upper or middle jejunum, would evacuate the gall-bladder.[11]

Nevertheless, Bianchus must be given credit for his understanding of the mechanism which controls the filling of the gall-bladder.

> Other observations [he writes] and these the most vigorous, prove the distribution of bile from the liver duct into the gall bladder. The oblique insertion of the bile-bearing duct in the intestine, furnished with a circle of firm flesh at its opening, a sphincter, so to speak, prevents the free filtering of the bile into the intestine; and so in this way the liquid which has just now escaped the meeting with the cystic opening, being easily driven back into its own channel, can be compelled to enter this same opening and to descend into the bladder.

Here is an 18th century observation which has stood the test of time and probably justifies the resuscitation of Joannes Baptista Bianchus.

Edward A. Boyden

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Detroit, Mich., Sept. 27-30, 1932.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: New Orleans, La., May, 1932.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: New Orleans, La., May 9-13, 1932.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual Meeting: Atlantic City, N.J., Nov. 28-Dec. 2, 1932.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, Dr. D. R. MacColl, 2826 S. Hope St., Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Birmingham, Ala., Nov. 16-18, 1932.

BROOKLYN ROENTGEN RAY SOCIETY
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BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. A Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
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Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Herpel, Good Samaritan Hospital, West Palm Beach, Fla.
Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. L. M. Hilt, Myers Bldg., Springfield, Ill.
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INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next Meeting: St. Paul, Minn., May 23, 1932.

NEW ENGLAND ROENTGEN RAY SOCIETY
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Meets monthly on third Friday, Boston Medical Library.

NEW YORK SOCIETY
Secretary, Dr. J. Bennett Edwards, Englewood Hospital Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. M. T. Powers, 250 Genesee St., Utica, N. Y.
Three meetings a year—January, May and November.

PENNSYLVANIA RADIOLOGICAL SOCIETY
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Next meeting, to be announced.

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ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. E. W. Spinzig, 316 Metropolitan Bldg.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Virginia Roentgen Ray Club
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburgh, Va.
Next meeting, to be announced.

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Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 p.m., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 p.m. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Societe de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German Univer ty, Prague, 11/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

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Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

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Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
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All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets first Tuesday each month, October to July.

Orient

Japan X-ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

AMERICAN COLLEGE OF PHYSICIANS TO AWARD PRIZE TO DR. O. T. AVERY

The American College of Physicians recently selected Dr. O. T. Avery of the Hospital of the Rockefeller Institute of New York City as the recipient of the John Phillips Memorial Prize for 1932.

This prize, an annual award by the College in the sum of $1500.00, is given to perpetuate in the College the memory of Dr. John Phillips of Cleveland, a man of outstanding accomplishments as investigator, teacher and physician, for many years a member of the Board of Regents of the American College of Physicians, who gave his life in saving others on the occasion of the Cleveland Clinic disaster on May 15, 1929.

The Committee on the John Phillips Memorial Prize, through its chairman, Dr. James H. Means of Boston, recommends the award, "To Dr. O. T. Avery for the series of studies upon the Pneumococcus in which he has played a leading rôle, beginning with the discovery of the type-specific soluble capsular polysaccharides and culminating in the discovery of a bacterium producing an enzyme which splits the polysaccharides of Type III pneumococcus in vitro, thus rendering it susceptible to phagocytosis and thereby protecting the animals infected with it."

The Sixteenth Annual Clinical Session of the College will be held in San Francisco during the week of April 4, 1932. Dr. Avery will deliver an address, "The Role of Specific Carbohydrates in Pneumococcus Infection and Immunity," at the Convocation on Wednesday evening, April 6. At the conclusion of Dr. Avery's address, the prize will be presented to him by Dr. S. Marx White of Minneapolis, President of the College.

The distinction of this award is enhanced by the fact that although it was available the previous year, it was not possible to decide on a suitable recipient. This is, therefore, the first award made. It is the hope of the officers and members of the College that this annual prize in memory of a distinguished colleague may, by recognizing merit, be a continuing stimulus to investigators in those subjects having a direct bearing on the advancement of Clinical Science.

MINNESOTA RADIOLOGICAL SOCIETY

The winter meeting of the Minnesota Radiological Society was held at the University Hospital in Minneapolis on Saturday, February 13, 1932. The following program was presented:

Clinical-Pathological-Radiological Conference

Conducted by Dr. W. A. O'Brien
Assisted by Drs. B. Pearson,
O. Randall, R. Koucky

1. Ewing's Sarcoma of Bones. Discussion by Drs. W. Cole, C. Hansen.

2. Multiple Myeloma with Intestinal Obstruction. Discussion by Dr. O. H. Wangensteen.

3. Carcinoma of Breast with Multiple Metastases. Discussion by Drs. K. Stenstrom, O. Campbell, L. Rigler.

4. Carcinoma of Antrum with Peripheral Metastases. Discussion by Drs. W. Peyton, K. Stenstrom.

Relative Value of Stereoscopic and Single Films in the Routine Examination of the Chest, Dr. Frederick B. Exner.

Studies on the Routine Examination of the Chest in Students, Dr. Harold Diehl.

Anomalous Lobes of the Lungs, Dr. L. G. Ericksen.

Observations on Intrapleural Pressure in Massive Pulmonary Atelectasis, Dr. Rudolph Koucky.

Radiation Therapy of Neuritis, Dr. John J. Eneboe.

Fractures of the Sesamoids, Dr. Jacob Sagel.

Methods of Radiation Therapy of Carcinoma of the Esophagus, Dr. C. O. Hansen.

Intraperitoneal Herniae—Preliminary Report, Dr. Frederick Exner.

The Use of Thorotrast in Roentgen Diagnosis—Preliminary Report, Dr. L. G. Ericksen.

ADDRESSES

The Recent Literature on the Classification and Treatment of Bone Tumors, Dr. W. A. O'Brien, Professor of Pathology, University of Minnesota.

Cholecystographic Studies on the Emptying of the Human Gall-Bladder, Dr. E. A. Boyden, Professor of Anatomy, University of Minnesota.

The next meeting of the Society will be held in St. Paul, Minn., May 23, 1932.

ILLINOIS RADIOLOGICAL SOCIETY

The January meeting of the Illinois Radiological Society held at Bloomington, Illinois, marked the tenth anniversary of this Society.

The scientific program consisted of the following papers:

"X-ray Treatment of Thyroid Diseases," by Dr. E. L. Jenkinson, Chicago, Ill.

"Primary Gall-Bladder Films Versus Cholecystography," by Dr. Robert A. Arens, Chicago, Ill.

"Some Interesting Historical Data Regarding the Roentgen Rays," by Dr. I. S. Trostler, Chicago, Ill.

The officers of the Society for 1932 are Dr. Fauntleroy Flinn of Decatur, Illinois, President, Dr. J. S. Archibald of Danville, Illinois, Vice-President and Dr. Lawrence M. Hilt, Springfield, Illinois, Secretary.

The regular Meetings of this Society are held quarterly.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Zehn Jahre Forschung auf dem physikalisch-medizinischen Grenzgebiet. (Ten Years' Research in the Physical-Medical Borderline Region.) Bericht des Institutes für physikalische Grundlagen der Medizin an der Universität Frankfurt am Main. Edited by o. ö. Prof. Dr. Friedrich Dessauer, Direktor des Institutes. Cloth. Pp. 403, with 190 illustrations and one colored plate. Leipzig: Georg Thieme, 1931.

This work presents a very thorough summary of the borderline researches in the field of biophysics at the well-known Institute for the Study of the Physical Foundation of Medicine at the University of Frankfurt. It is divided into eighteen sections written separately by Prof. Dessauer and his workers. Most of the material has been published previously in separate communications. The first section, comprising nearly half of the book, describes their investigations on the production and medical use of unipolar charged or ionized air. Complete descriptions of the apparatus in all its stages of development are given, and all the physical properties of the ionized air are discussed from the theoretical as well as experimental viewpoint so that the collected chapters make a very thorough treatise on the subject. Clinical experiments are described in detail, giving the effects of different kinds of ions on the blood. This is followed by a presentation of Dessauer's theory of the biological action of radiation with some of the experimental proof of the theory. As a corollary to this theory there is presented a physical picture of the action of radiation on cells, giving an excellent discussion of the experiments on the equivalence of action of ultraviolet and roentgen rays. Extensive studies have been carried out seeking to prove the existence and action of the Gurwitsch mitogenetic radiation. The new and extremely sensitive measuring apparatus necessary to detect this radiation is described in detail. Two short chapters describe their work on the roentgen-ray intensity distribution in irradiated bodies (depth dose charts) and the synthetic production of ammonia. Preliminary results are given on the measurement of high speed cathode rays in air (Lenard rays) made with the view to their biological application. The remaining ten sections describe in less detail a host of other developments and investigations including the following: a universal apparatus for measuring radiation (roentgen rays, grenz rays and ultraviolet), heavy ions in the atmosphere, erythema and tolerance doses in American clinics (Glasser), apparatus for the production of high voltages, apparatus for the measurement of high frequency electromagnetic radiation, roentgen rays and gamma rays. It is obvious that an extremely broad range of subjects has been covered and their presentation as a unit is believed to be helpful in order that we may better grasp the full importance of the application of physics in the field of biology.

Lauriston S. Taylor

I sintomi radiologici locali degli stadi di sviluppo dell ulcera duodenale. (The Local Roentgen Signs of the Stages of Development of Duodenal Ulcer.) By Dott. G. Martinotti. From the Instituto Radiologico of Turin, Italy (directed by Drs. Martinotti and Segre). Paper. Pp. 159, with 58 tables accompanied by numerous sketches in the text. Published by Tipografia Editrice "Minerva," Turin, 1931.

This monograph is an atlas of 58 tables (consisting each of the reproduction of four roentgenograms, and accompanied by an explanatory sketch) of the changes induced in the duodenum by ulcer, seen roentgenologically, and which depend on the location of the lesion and the stage of its development. The author feels that the ordinary classifications of ulcer are incomplete, so he presents one of his own: (1) ulcer of the base, juxtapyloric; (2) ulcer of the base, parapyloric; (3) ulcer of the middle portion of the walls; (4) ulcer of the lateral portion of the walls, and (5) ulcer of the distal portion of the walls. He next classifies the three stages of development of ulcer of the duodenum, as observed roentgenologically, the initial ulcer, the ulcer with areas of sclerosis, and the results of the sclerosis. By means of the tables which il-

lustrate typical roentgen findings the author clarifies this interesting and important lesion, simplifies its differential diagnosis, emphasizes the important signs manifested by ulcer, and warns against the commonest pitfalls by which a lesion is missed. The make-up of the book is excellent. The presentation is so concise that one even with no knowledge of Italian easily becomes familiar with the author's concept of duodenal ulcers, and it should be of great interest in simplifying the study of this very important segment of the gastrointestinal tract.

E. T. Leddy

Esame radiologico dello stomaco e del duodeno. (Roentgen Examination of the Stomach and the Duodenum.) By Prof. Alessandro Vallebona, with a preface by Prof. Vittorio Maragliano. From Instituto di Radiologia e di Electroterapia della R. Universita di Geneva, Padiglione di Radiologia e terapia fisica degli Osp. Civ., Geneva. Paper. Pp. 341, with 114 illustrations. Bologna: Licinio Capelli, 1931.

This is an enlarged presentation of the "combined method" developed by the author since 1925 for the examination of the stomach and duodenum. This method consists in the administration of four grams of tartaric acid and four grams of bicarbonate of soda in a small quantity of water which produces a slow and smooth dilatation of the stomach to complement the usual opaque meal. Throughout the book the presentation of roentgenologic findings as obtained by this method is emphasized almost to the exclusion of the ordinary methods. The great majority of the 114 illustrations in the text are reproductions of roentgenograms obtained by the "combined method," rarely accompanied by the more orthodox type of picture. The book is a systematic, lucid presentation and critique of the methods of examination of the stomach and duodenum, and in it the advantages, the limitations and the possibilities of the author's method are presented. The book merits serious consideration by all gastro-enterologists and roentgenologists.

E. T. Leddy

Guide to Radiologic Diagnosis in Heart Disease. Prepared with the aid of the Committee on Research of the Heart Committee by Geza Nemet, M.D. Paper. Price, 35 cents. Pp. 25, with 31 illustrations. New York: New York Tuberculosis and Health Association, Inc., 386 Fourth Avenue, 1931.

This pamphlet is a welcome addition to any physician using the roentgenoscopic method for diagnosis. It is welcome because it is the first attempt at a simple account of the method. Its author admits that the account is incomplete and inadequate, but expresses the hope that now that a start has been made, later revisions and additions will contain such improvements as to make it satisfactory. The additions will have to be multiple and considerable will have to be done to make the pamphlet of any great use. It was intended to be brief, but its brevity defeats its purpose. The information it contains I fear would only lead the inexperienced astray and would add nothing systematic to those with experience in the method. Roentgenoscopic observation of the heart has many advantages not found in any other means of physical diagnosis. Its importance is not generally recognized in this country and such a brief description does not give a fair insight into its possibilities.

David Steel

Studies in the Photo-activity and Therapy of the Tungsten-Titanium Arc. By J. Burdon-Cooper, M.D., B.S., B.Sc. (Durh.), F.R.C.S.E., D.O. (Oxon.), F.C.S., Late Lecturer Physiological Optics, Department of Ophthalmology, University of Oxford; Doyne Lecturer and Medal, Oxford Ophthalmological Congress; etc., and Arthur Roberts, T.D., F.R.C.S.E., M.R.C.S. (Eng., Major R.A.M.C. (Ret.); Consulting Aural Surgeon, etc. Cloth. Price, $3.50. Pp. 85, with illustrations. New York: William Wood & Co., 1931.

This monograph has been written in order to supply information gained by the authors during the last three years with a therapeutic lamp using a composite electrode of tungsten and titanium. In the first part the emission of the tungsten-titanium arc is analyzed, mostly by the spectral method; a large number of spectrograms are appended. The results can be summarized as follows: The spectrum of the arc contains about 50 per cent short erythema producing rays, 25 per cent long non-erythema producing rays and 25 per cent visible rays in the photo-active part of the light spectrum. This compares very favorably with the pure tungsten arc, which, according to the authors

has, for instance, only 42 per cent of short erythema producing rays. The times for producing identical skin reactions are 1.8:1 in favor of the tungsten-titanium arc.

In the second and clinical part of the book the clinic model of this arc, known as the Crombie lamp, is described with its accessories. Detailed instructions are then given as to the proper use of the equipment. The general effects following the exposure are also outlined; they are illustrated by excerpts from a patient's letter describing his experience after the use of this lamp. As appears from the next chapter beneficial results will be obtained in eczema, acne, alopecia, general debility, circulatory disturbances, asthma, anemia and rheumatic conditions. Numerous histories are quoted taken from the files of Dr. Roberts. In conclusion, the authors state that this monograph is offered as the "groundwork of a sincere conviction that the tungsten-titanium arc not only has potential energy and characteristics that are in some respects unique, but also possesses a clinical value in general actinotherapy which we cannot well afford to ignore."

Ernst A. Pohle

Books Received

Surgery of the Chest. By George F. Straub, M.D., F.A.C.S. Cloth. Price, $10.50. Pp. 475, with 341 illustrations, including 68 color plates. Springfield, Ill.: Charles C Thomas, 1932.

Clinical Roentgen Pathology of Thoracic Lesions. By William H. Meyer, M.D., Professor of Roentgenology in the New York Post-Graduate Medical School of Columbia University; Director of Roentgenology in the New York Post-Graduate Hospital. Cloth. Price, $6.00. Pp. 272, with 183 illustrations. Philadelphia: Lea and Febiger, 1932.

Courts and Doctors. By Lloyd Paul Stryker. Cloth. Price, $2.00. Pp. 236, with no illustrations. New York: The Macmillan Co., 1932.

Röntgendiagnostik der Erkrankungen innerer Organe in Tabellen und Skizzen. Von Dr. Emmerich Markovits, Vorstand des Röntgenlaboratoriums im Krankenhause des städt. Armenheimes in Budapest "wissenschaftlicher Mitarbeiter" des Zentral-Röntgeninstitutes des Allgemeinen Krankenhauses in Wien. Mit einem Geleitwort von Hofrat Prof. Dr. G. Holzknecht, Vorstand des Zentral-Röntgeninstitutes des Allgemeinen Krankenhauses in Wien. Second, enlarged edition. Paper, price M. 15; bound, M. 17.50. Pp. 223, with 429 illustrations. Leipzig: Georg Thieme, 1931.

Die Dickdarmschleimhaus, ihre normale und pathologische Funktion im Röntgenbilde. Von Priv.-Doz. Dr. Werner Knothe, Leiter der Röntgenabteilung der II. medizinischen Universitätsklinik der Charité, Berlin (Direktor: Prof. G. v. Bergmann). Bound. Price, M. 8.00. Pp. 56, with 113 illustrations. Leipzig: Georg Thieme, 1932.

Précis de radio-diagnostic. Par P. Lamarque, Professeur agrégé à la Faculté de Médecine de Montpellier. Preface by Professeur E. Forgue, Associé national de l'Académie de Médecine, Membre correspondant d l'Institut. Bound. Price, 125 fr. Pp. 746, with 374 illustrations. Paris: G. Doin & Cie, 1932.

United States Army X-Ray Manual. Authorized by the Surgeon-General of the Army. Second edition, rewritten and edited by Lt. Col. H. C. Pillsbury, M.C., U.S.A. Bound. Price, $5.00. Pp. 482, with 228 illustrations. New York: Paul B. Hoeber, Inc., 1932.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, 105 Rutledge Ave., Charleston, S. C.

METHOD AND APPLIANCES FOR THE RAPID EXAMINATION OF WET ROENTGEN-RAY FILMS*

By SHERWOOD MOORE, M.D.
ST. LOUIS, MISSOURI

IN EVERY roentgen laboratory there are at times cases of urgency in which it is not only desirable but necessary that roentgenograms be examined before they have been through the complete dark room process. Unless provision is otherwise made for this purpose, this means the stopping of all dark room activities while the films are examined. The use of white light in examination of the films in the dark room is a most time-consuming and demoralizing affair for those who work there. In addition to the acute phase of the problem of rapid examination of films as stated, there is another important aspect of the matter. It is unquestionably true that however excellent a roentgen laboratory's technique and methods may be, it is unfortunately also true that the method of trial and error must be followed to secure the best results in roentgenography. This means that films should be examined as a routine at the earliest possible moment in the course of the dark room process. This is essential for the production of the optimum of technical excellence with a minimum wait of the patient. Therefore, some method whereby a film might be examined as soon as it is possible to visualize it would greatly expedite a roentgen examination both in the acute cases and those which are routine. This would assure a great saving in both time and material.

The usual practice in roentgen laboratories is to stop all dark room work while films are examined. In smaller laboratories this is quite practical and can be done with little inconvenience to the orderly and systematic conduct of the laboratory. In larger institutions such a method is almost prohibitive because of waste of time. None of the attempts to overcome the drawbacks attending immediate film examination are satisfactory. They consist of two methods: in the first, the use of special dark rooms for emergencies and in the second, light proof "pass boxes" are used through which films may be passed out into a lighted room, there inspected and then returned to the dark room. The first of these means the expense of an additional dark room and the second entails a great waste of time while the dark room technician locates in his solution tanks and dryer the films that are wanted. Nearly all roentgen laboratories are making an effort to wash and dry films in a lighted room situated off the dark room so that films can be inspected readily. Most of the methods that have been examined leave something to be desired.

The dark room in the Edward Mallinckrodt Institute of Radiology (formerly the X-ray Department of the Barnes Hospital) was designed and constructed with the intention of expediting film examination. The dark room proper is small, relatively inaccessible and is unprovided with lights suitable for film examination. It has a light proof transfer box through which the films are passed as soon as they are "cleared" by the hypo solution. The transfer brings the films into a specially designed corner of a technician's service room, where the remaining steps of fixing, washing and drying are completed. All through these processes the films are accessible for purposes of viewing, and, meanwhile, the work of the dark room goes on uninterruptedly.

* From the Edward Mallinckrodt Institute of Radiology, St. Louis, Mo. Received for publication December 19, 1931.

The advantages of this system in emergency cases requires no comment.

Films in which the quality for any reason is unsatisfactory or those in which films of the opposite member are desired, or any similar cause, can be made with a minimum lapse of time. This is economically important because in the hospitals with which the Edward Mallinckrodt Institute of Radiology is allied, fairly accurate estimates reveal that the cost of transport of a patient to the laboratory is fifty cents. In consequence, every effort is made to eliminate "retakes" and this physical arrangement of the dark room eliminates them to a great extent. A more important point than economy alone is that this method permits the attending physician to secure information at the earliest possible moment. The benefits accruing to the patient from this method are obvious.

As has been stated above, systems of handling films similar to that described are in use in other laboratories.

Even with ample provision for the early examination of films by a system such as that which has been described, there is always a great loss of time while the films which are wanted are being located. In order to find them they must have identification marks. There are two principal methods of marking roentgen films for purposes of later identification. In one the necessary data are photographed on the film at the time of exposure and in the others they are written on it just before development. The former is most commonly a numerical system and the latter an alphabetical one.

For many years the policy of this roentgen laboratory has been to use not a number but a name method of identification of films. It has been found that having the dark room technician write the name of the patient in pencil on the undeveloped film (along with any additional data that may be necessary) results in fewer errors than any other system. This method is legally acceptable in this locality. For the convenience of the attending physician the

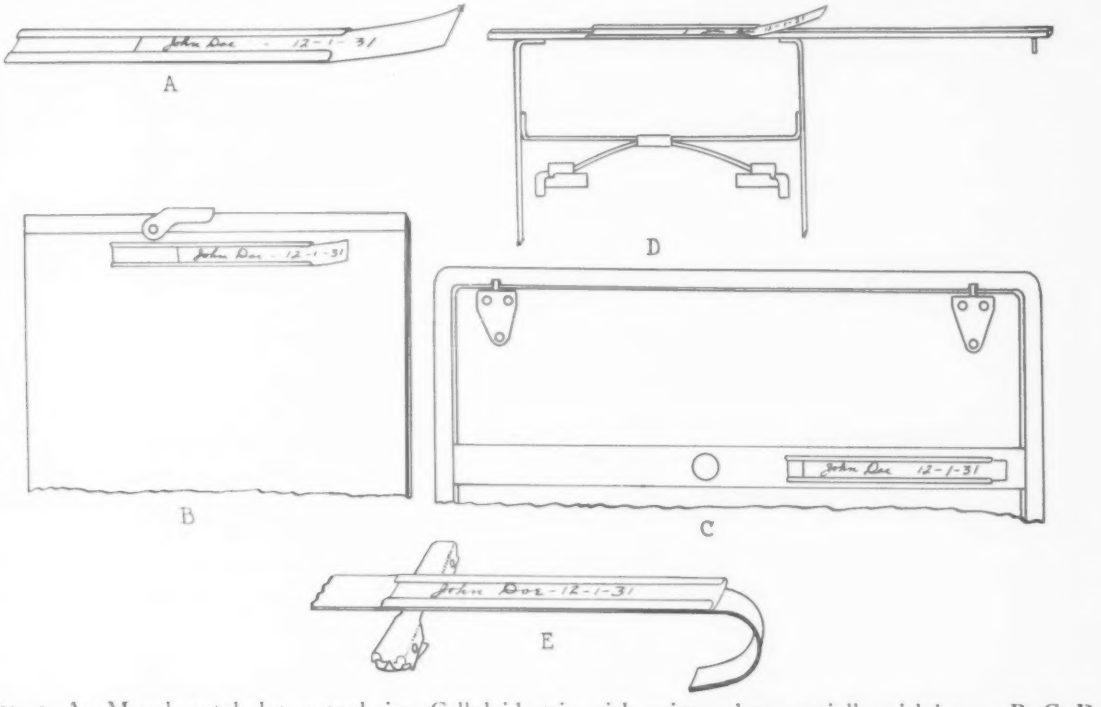

Fig. 1. A—Monel metal slot, actual size. Celluloid strip with written data partially withdrawn. B, C, D and E—Illustrate the monel metal slot attached to film holder, cassette, developing rack and dental film rack respectively.

fully processed film has a typewritten paper label. This has the patient's name, the date, the service and the film number and other facts if desired. Examination of such films can be rapidly carried out because of the immediate and ready identification. However, the identification of films before labeling and for the purpose of labeling has been time consuming and difficult.

Much thought was given to this troublesome problem for a long period. We have at last evolved a system which appears to solve it. It is relatively inexpensive, rapid in operation and minimizes errors. The greatest difficulty encountered was to secure a material which could be written on, be easily legible and remain unaffected by the solutions. It would also have to follow a film throughout the whole cycle of exposure, development, fixing, washing, drying and labeling. Strips of white celluloid with rough surface to permit writing would answer this purpose if one were able to devise a scheme for adjusting the strips to the various appliances which carry the films—film holder, cassette, developing rack and dental film holder. These articles could not be modified in such a way as to carry the celluloid strips. After a trial with many types of clasps and other means of attaching the strips, the solution of this difficulty was reached. A monel metal slot was made of the largest width practical for use in tanks and dryers and of a length suitable to carry sufficient written data. This slot is shown in Figure 1, A, with the celluloid strip partially withdrawn. The cut gives ample information of the nature of this slot. The slot is cold-pressed out of sheet monel metal a few millimeters in thickness. The width of the opening is 0.75 cm.; this is the maximum practical size. These slots are riveted to the reverse side of the film holders (Fig. 1, B). They are soldered to the springs on the backs of the cassettes (Fig. 1, C), to the cross bar of the developing rack (Fig. 1, D) and to the reverse side of the dental film holders (Fig. 1, E). The overhang of the slot margins is just sufficient to permit of snug engagement of the celluloid strip which is cut a trifle longer than the slot itself so that it is readily inserted and removed from it. It is important to have such a fit so that there is little chance of the celluloid strip being lost from the slot. Such an occurrence would be troublesome but with the practice of writing on the film, employed in this laboratory, the film would not be hopelessly lost after it had once reached the dark room.

In summary, our procedure with the new dark room arrangement and new appliances is as follows: When film holders and cassettes are loaded in the dark room, blank celluloid strips are at the same time inserted into the slots. When the film is exposed the patient's name and such other data as are wanted are written in pencil on the celluloid strip in the slot. The cassette or film holder reaches the dark room, the celluloid strip is slipped out, the data written on the exposed film and then the celluloid strip is placed in the film holder (or dental film holder, as the case may be). The film then proceeds through the developer, fixing, washing and drying, as has already been outlined, and once it has passed out of the dark room it can be readily identified and examined at any time. When the film is dismounted from the developing rack the celluloid label is attached to the film with an ordinary paper clip and this speeds up the labeling. Celluloid strips that have been through the process have the name and other data erased and are returned to the dark room, and as cassette and film holders are loaded these strips are again put in the slots.

This method has increased the accuracy and speed of the roentgen technicians and has conserved their time. In this respect it is of great value to patients and attending physicians. It has almost eliminated the bane of a roentgen laboratory, that is, scratched and defaced films. Altogether this system has proved eminently satisfactory both to the department and those having occasion to use it.

At least two recent vistors to the Edward

Mallinckrodt Institute of Radiology have stated that they have a similar method of film identification in use. I regret, therefore, that this method though original with us, is not original in fact and the desire to have it published is based on the hope that manufacturers will market such devices. If they do so it will certainly be a boon to roentgenologists. If a roentgenologist independently evolves a system comparable to the one outlined he will waste much time and have much trouble in doing so. For these reasons the description of this method and the necessary appliances is submitted for publication.

SIMPLIFIED DARK-ROOM ILLUMINATION*

By GEORGE LEVENE, M.D.

BOSTON, MASSACHUSETTS

THE following method of dark-room illumination has proved to be both simple and efficient.

The unique features are embodied in the use of a three-point electrolier switch for

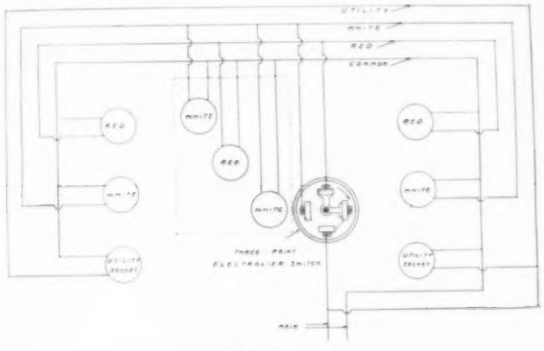

FIG. 1.

the control of all lights in the dark room, including those used for developing and for inspection of the films and in the method of wiring the "safe-light" over the tanks.

The "safe-light" is a metal box having a window 14×17 inches and it is recessed so that its surface is flush with the wall. Instead of the usual ruby glass or cloth, the box has a diffusing, ground-glass window. It contains a 15 watt ruby lamp and two 50 watt white lamps. This box serves the purpose of an excellent developing safe-light. It does not "fog" the films. Because of its size and position it facilitates inspection of films in process of developing.

The switch is conveniently located near the developing tanks and by successive turns will cause the lights to be red, out, white, out.

When the switch is turned so that the white lights are on, the "safe-light" becomes an illuminating box, permitting the inspection of developed films at the tank and eliminating the use of doors or slides with which the usual dark-room lamps are ordinarily equipped.

A number of utility sockets which afford a continuous supply of current, whether the lights are red, white or out, are provided for the use of dryers, fans and other dark-room accessories.

* From the Department of Roentgenology of Evans Memorial for Clinical Research and Preventive Medicine, Boston, Mass.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Lorey, A., and Mylius, K. Die Röntgenbehandlung tuberkulöser Erkrankungen des Auges. (Roentgen treatment of tuberculosis of the eye.) *Strahlentherapie*, 1930, *38*, 437–486.

The roentgen irradiations were given with stabilivolt or metro tubes and the doses measured in the air. The focus-skin distance was 25 cm. Two different qualities of rays were used: 110 kv. with a filter of 3 or 5 mm. aluminum, and 170 kv. with a filter of 0.5 copper and 1.0 aluminum. There was no special difference in effect between the harder and softer irradiation. The individual doses varied from 50 to 200 r, 100–125 r being the best. The irradiation should not be repeated before one to two months and not more than 3 or 4 irradiations should be given in a year.

Radium was found to give better results than roentgen rays in tuberculosis of the conjunctiva. It requires some time to bring about disappearance of the proliferations; if there are large proliferations it is better to cauterize them before giving the radium treatment. In some cases a small superficial apparatus containing the radium was used, in others emanation. The dose given was 3.5 mg-hr. per square centimeter.

The results of roentgen treatment were particularly good in tuberculosis of the cornea. Individual doses of 100–125 r were given and not more than 400 r in the course of a year. Irradiation is indicated in all cases of tuberculosis of the cornea which are refractory to other methods of treatment and show a great tendency to recurrence.

The results were not nearly so good in iridocyclitis; among the 20 cases treated there were only 2 complete recoveries. There was improvement in a number of other cases. The therapeutic effect seemed to be brought about by the first dose and repetition of the treatment and increase of the dose did not have any further effect. There may be bad late effects after months or years if too large doses are

used. Recently a number of cases of tuberculosis of the retina and choroid have been given roentgen treatment; 3 cases of disseminated choroiditis were treated, one with large miliary tubercles and 2 with recurrent hemorrhages of the vitreous body. The results were not very good. Increasing opacity of the lens was seen in all irradiated cases of severe iridocyclitis. It is hard to say in many cases whether this was caused by the specific inflammation or by the treatment.

Patients given radiotherapy should always be given a card showing the amount and kind of irradiation they have had, so that if they are treated elsewhere the exact amount given may be known.—*Audrey G. Morgan.*

Rohrschneider, W. Über die Wirkung der Röntgenstrahlen auf das Auge. (The effect of roentgen rays on the eye.) *Strahlentherapie*, 1930, *38*, 665–683.

Röntgen in 1897 reported that the new rays that he had discovered had a stimulant effect on the retina. The sensation of light when the eye is irradiated directly has been the subject of a great deal of controversy. Some have attributed it to a direct stimulant action on the retina and others to an indirect one due to fluorescence. It was at first hoped that this stimulation of the visual epithelium by the rays might cure the blind in whom the light-perceiving part of the retina was not yet injured, but irradiation for this purpose was soon found to be not only useless but dangerous.

The author made experiments on rabbits to determine what part of the eye is most sensitive to the rays. The rabbit's eye is less sensitive to the rays than that of man, however. He used as a unit the epilation dose of the rabbit which is about twice as large as the human skin unit dose. He found that the lens is the most sensitive part of the eye and that it is injured by an epilation dose, or about 180 per cent of a skin unit dose. In the rabbit, cataract is always caused by an epilation dose but this does not occur with such constancy in man. In roentgen treatment, however, the dose should be kept well below the epilation dose if the eye is not to be injured. This is true not only of a single large dose but also of smaller fractional doses.

Roentgen injuries of the eye generally occur in treatment of tumors of the skull and brain; the eye should therefore always be carefully protected in irradiating such tumors. Roentgenologists rarely suffer injury of the eye in their work.

This does not mean that roentgen rays should never be used in treatment of the eye. The excellent results that have been attained show that with rational dosage and sufficient protection injury can be prevented; but the roentgenologist must know the sensitiveness of the different parts and regulate his dosage accordingly.—*Audrey G. Morgan.*

Desjardins, Arthur U. Radiotherapy for inflammatory conditions. *J. Am. M. Ass.*, Feb. 7, 1931, *96*, 401–408.

The value of radiotherapy in treatment of inflammatory conditions rests on a sound clinical and experimental basis. Such treatment is easy, inexpensive, painless, without general reaction and is generally of benefit, never producing injurious effects. It may render surgery unnecessary, though it does not replace surgical observation and care. Very favorable results have been reported in furuncles, cellulitis, pneumonia, trachoma, erysipelas, parotitis, nephritis, otitis media, mastoiditis, epididymitis, parametritis, mastitis, sinusitis and numerous other inflammatory conditions. Acute osteomyelitis has not responded so well. The technique of radiologists reporting generally unfavorable results is seriously open to question. Small doses give best results, the optimum being between 10 and 50 per cent of the erythema dose. Usually one treatment is sufficient and it is most efficient if given during the stage of leucocytic infiltration before actual suppuration takes place. Of many theories regarding the action of roentgen rays on inflammatory processes, that of lymphocytic destruction is most plausible. The lymphocytes probably contain protective substances which are more available for defense against invading organisms when liberated from the cells by their disintegration. Radiation has an effect directly proportional to the number of lymphocytes present.

Numerous references are appended.—*E. W. Hall.*

ten Doornkaat-Koolman, Menna. Ein Fall von Lymphogranulomatose klinisch geheilt seit 4 Jahren. (A case of lymphogranulomatosis clinically cured for four years.) *Strahlentherapie*, 1930, *38*, 147–151.

A case of lymphogranulomatosis is described in which treatment was begun in 1924. The

patient, a boy eleven years old at that time, had enlarged glands of the occiput, neck, inguinal region and an extensive process at the hilus of the lung. The treatment consisted of four series of deep roentgen irradiations from June 24, 1924, to May 23, 1925, and repeated sojourns at a high altitudes, some of them prolonged. Since the beginning of 1926 the patient has been completely well clinically. His physical development has been excellent and now (June, 1930) he is able to work normally.—*Audrey G. Morgan.*

Billich, H. U. Zur Röntgenbestrahlung der Lymphogranulomatose. (Roentgen irradiation of lymphogranulomatosis.) *Strahlentherapie*, 1930, *38*, 141–146.

Lymphogranulomatosis generally begins with a circumscribed enlargement of the lymph glands, more frequently those of the neck than those of the axilla or inguinal region. But in this early stage it is frequently mistaken for harmless hyperplasia of the glands or tuberculosis so the patients rarely come for treatment until the second stage when the general health is affected.

The author reports 31 cases, in which the diagnosis was confirmed by histological examination, treated by roentgen rays; 35.5 per cent of these lived two years and longer, 29 per cent of them three years or longer. One boy nine years of age is alive five years after treatment without any evidence of gland disease, and a nineteen year old girl was still able to do her work as a nurse three years after treatment but is now under treatment for a recurrence.

Six or eight years ago the author used 80–100 per cent of a skin unit dose but finds it best now to use the smallest possible effective dose as that prevents the glands from becoming refractory. In cases with soft glands in which larger doses might cause severe injury of the general health, he now often begins with 20–30 per cent of a skin unit dose, or for the mediastinum even 5–15 per cent, and in this way can irradiate a long time without injuring the skin. He uses a moderately hard radiation of 170–180 kv., 5 ma., and a filtration of 0.5 mm. zinc and 1.0 mm. aluminum, with a focus-skin distance of 30 cm. No uniform plan can be given for the time of the treatments as the interval depends on the reaction in each individual case. He has not had good results from the American plan of prophylactic irradiation of the whole lymph gland system but prefers local irradiation of the diseased glands. He sometimes irradiates the spleen with small doses and has seen this result in marked improvement in the blood picture. He has also sometimes given thorium X intravenously in doses of from 1000 to 3000 units with good results.

Lymphogranulomatosis is still an incurable disease but life can be considerably lengthened with roentgen treatment and it is the best treatment so far known.—*Audrey G. Morgan.*

Siciliano, L. Zur Radiotherapie der Hamopathien. (Roentgen treatment of blood diseases.) *Strahlentherapie*, 1930, *38*, 791–792.

The changes in the circulating blood brought about by roentgen irradiation are not entirely due to the destructive action of the rays on the blood cells, which are quite resistant to roentgen rays, but rather to an indirect action through proteins set free by the action of the rays on the tissues entering the blood. The changes in animal experiment and in normal human beings are not the same as those under pathological conditions; the violent proliferation in blood diseases causes greater sensitiveness of the cells to the rays. Irradiation of spleen and bone marrow causes changes in distant hematopoietic tissue and the good effect seen in certain systemic diseases, such as leucemia, erythemia and lymphogranulomatosis are doubtless due to this general action which is caused by chemical substances set free from the irradiated tissues, particularly hematopoietic tissue. Ultimately an inhibition is brought about which puts a stop to the excessive production of blood cells.

While in general the white cells are more sensitive to rays than the red ones, under pathological conditions those cells are the most sensitive, the increase of which has caused the disease. For instance in erythremia a reduction of the red cells may be brought about without a decrease of leucocytes and in lymphogranulomatoses a reduction of the lymph nodes can be caused without a leucopenia; this latter fact is remarkable because under normal conditions the reticulo-endothelial system is less sensitive to rays than the blood cells. In hemorrhagic diatheses, too, the rays have a good effect but it is temporary. Generally the spleen is irradiated, though it does not seem to have a specific effect on coagulation and clinical improvement is not always accompanied by increased coagulability. A part of the effect at

least seems to be due to an action on the blood capillaries.

In the radiotherapy of blood diseases the dosage and the cycle of irradiations must be adapted to each case, watch being kept of the changes in the blood picture. In leucemia further irradiation should not be given until the leucocyte count has become stabilized after the previous one. Though roentgen therapy has given brilliant results in some cases it does not cure blood diseases radically.—*Audrey G. Morgan.*

Fürst, Walter. Vergleichende Untersuchungen uber Blutschädigungen durch Röntgenstrahlen bei dem alten Bestrahlungsverfahren und bei den strahlenschutzsicheren Metalixröhren. (Comparative study of injuries to the blood by roentgen rays with the old method of irradiation and with Metalix protective tubes.) *Strahlentherapie*, 1930, *37*, 659–692.

With the old method of irradiation the patient is affected not only by the useful cone of rays but also, either directly or indirectly, by available undesirable irradiation. The author attempts to measure the amount of undesirable irradiation as compared with the useful irradiation, and confirms the fact that with Metalix tubes there is no avoidable undesirable irradiation. He gives tables and curves of 3 cases showing the effect on the blood of irradiation with ordinary tubes and with Metalix tubes. He finds that with the latter the blood injury and therefore the general injury is considerably less with the same useful cone of rays, because the avoidable undesirable irradiation is eliminated.—*Audrey G. Morgan.*

Heeren, I. Zur Strahlenbehandlung der Pleuritis carcinomatosa bzw. sarcomatosa exsudativa. (Roentgen treatment of exudative carcinomatous or sarcomatous pleurisy.) *Strahlentherapie*, 1930, *37*, 735–750.

Before the beginning of roentgen therapy the fate of the patient was sealed when metastases developed. This was particularly true of metastatic tumors of the pleura. In metastatic carcinomatous pleurisy enormous amounts of fluid collect and compress the lung and the patient is tormented with cough and dyspnea; the circulation is also seriously damaged. Even with the older methods of roentgen treatment it was possible to treat circumscribed metastases but when they extended over large surfaces as in carcinomatous pleurisy energetic roentgen treatment sometimes hastened the death of the patient. But now since the introduction of treatment with moderate doses good results can be obtained even in such cases. Seven cases are described in which roentgen treatment with moderate doses gave excellent results. None of the cases grew worse and in most of of them the exudate disappeared in a relatively short time. Length of life was increased even in the patients who were not cured and they were relieved of the suffocation and dyspnea. The cause of death in the unfavorable cases was generally the occurrence of metastases in other parts of the body. Of the 7 patients, 4 are alive after more than a year without any signs of pleurisy. One patient died of liver metastases after a year of freedom from symptoms and 2 died in less than a year after only temporary improvement. If there are large amounts of exudate they should be emptied by puncture before treatment. The patients are irradiated from one large breast and one back field and a field in the axilla. If the pleurisy is bilateral one breast and two lateral back fields are used. If no pleural puncture is necessary 50 to 70 per cent of a skin unit dose is given, but in cases in which pleural puncture is necessary 90–100 per cent of a skin unit dose is necessary on account of the rapid reaccumulation of the exudate. The author used a stabilovolt apparatus with an irradiation of 190–200 kv., filtered through 0.5 copper, tension 5 to 7 ma., focus-skin distance 40 cm.—*Audrey G. Morgan.*

Hirsch, Henri. Hilfsmethoden bei der Strahlenbehandlung des Krebsleidens. (Auxiliary methods in the radiotherapy of cancer.) *Stralentherapie*, 1930, *37*, 767–778.

There are a number of auxiliary methods used to supplement surgery and radiotherapy in the treatment of cancer. Thermocoagulation as a preparation for irradiation has proved very valuable, particularly in carcinoma of the portio. For years the Erlanger Clinic has used the iontophoretic introduction of copper as a supplement to roentgen irradiation. Wintz thinks this acts primarily as a disinfecting method and only secondarily by sensitization by the copper. The copper particles must however produce secondary radiation, though it may be too small in amount to produce any great degree of sensitization.

Fischer-Wasels introduced the gas treatment of tumors. The mixture of gas that he uses has an intense oxidizing action and in the mouse has brought about necrosis of the tumor without injuring the organism but in man it seems to be only a supplementary method that stimulates total metabolism very energetically. Metabolism studies by the Warnekros Clinic showed that there is a lack of oxygen in the organism with cancer; they therefore injected chlorophyll which acts as a catalyzer in oxidative processes.

The reticulo-endothelial system is particularly sensitive to rays and so it must be spared as much as possible in irradiation. It can be activated in various ways, including weak irradiation of the spleen and giving splenic extract. Stain therapy also probably acts on the reticulo-endothelial system or the mesenchyme. In all autopsies the stains used, methylene blue, eosin, isamin blue and trypan blue, have been found only in the reticulo-endothelial cells but not in the tumor cells themselves. When the tumor cells have been broken down by irradiation the stains increase the absorptive capacity of the surrounding tissues; there is some danger, however, of blocking the reticulo-endothelial system by the use of stains. Other authorities combine metal treatment with the stain treatment. Kahn and Wirth report good results from bismuth treatment of tumors. Metal seems to injure the capillaries of the tumor and at the same time stimulate the reticulo-endothelial system; it also hastens oxidation and in this way inhibits the growth of the tumor, but it is hard to determine the toxic dose as the sensitiveness of different individuals differs greatly.

Dextrocid treatment is a sort of metal treatment. The cerium in the compound is a rare earth rendered non-toxic and the iod-cerium is combined with a hypertonic sugar solution. Iodine inhibits tumor growth and sugar solutions bring about an acidotic condition of metabolism which is inimical to tumor development. The author has introduced an improved dextrocid which he calls DXD 440 in which the dextrose-iodcerium combination is stronger in iodine and combined with calcium and a radioactive substance. Animal experiment has shown that when this compound is given intravenously a part of the radium is stored in the tumor.

Zondek has shown that activation of the hypophysis increases the defensive action of all the endocrine glands and irradiation of the hypophysis has considerably improved the results in 1700 cases at the Munich Gynecological Clinic

Organ extracts have been used to increase oxidation and improve the blood picture The author has stored organ extracts in an iod-cerium combination by a special method of dialysis and calls the product hipocid. This can be given by mouth combined with the administration of radioactive salts.

The variety of these auxiliary methods shows that there is no one universal method of curing cancer but that the biology and constitution of each individual patient must be studied and the treatment adapted to it.—*Audrey G. Morgan.*

Kremser, Curt. Über die Röntgenbehandlung der tabischen Reizzustände. (Roentgen treatment of tabetic crises.) *Strahlentherapie*, 1930, *38*, 719–729.

Forty-four cases are described in which the author gave roentgen treatment for tabetic crises. In 11 cases the treatment was a flat failure; in 4 there was slight improvement; in 20 there was considerable improvement at first but no late result. Only 9 patients were relieved of pain completely for periods of from three months to a year. As the lancinating pains in tabes often show spontaneous remissions, the objection has been made that it is impossible to determine the effect of irradiation; but many cases have been reported in which the pain stopped immediately after the irradiation. In one of the author's cases gastric crises stopped each time immediately after the irradiation. Differences in technique did not seem to make any great difference in the results. Several were tried and the author finally adopted the irradiation of only the affected root segments with 1/3 of a skin unit dose per field. Old cases seemed to react just as well to the treatment as recent ones.

Though the treatment showed long-continued effects in only one-fifth of the cases, the beginning results were good in two-thirds and in such an intensely painful condition even temporary relief is much to be desired. Roentgen irradiation therefore is a good symptomatic treatment in tabetic crises.—*Audrey G. Morgan.*

Kryński, A. Die Röntgenbestrahlung der Vertebralgegend bei einigen Dermatosen. (Roentgen irradiation of the vertebral region in

some dermatoses.) *Strahlentherapie*, 1930, *38*, 730–738.

Several forms of indirect irradiation have been tried in recent years. The author irradiated a strip 10 cm. broad over the spinal column in some dermatoses. Two treatments were given in one day. On the first treatment the rays were centered on the 2d to 3d thoracic vertebrae, on the second on the 12th thoracic vertebra with a focus-skin distance of 30 cm. In this way the whole region was irradiated practically uniformly; each of the fields was given a dose of 4 H with a maximum of 150 kv. through 3 mm. aluminum. The treatments were repeated after three weeks. After the third irradiation, if further treatment was needed, it was not given until after an interval of 6–9 weeks.

Thirty-seven patients with lichen ruber planus were treated in this way with complete cure in 24, or 65 per cent, marked improvement in 9, or 25 per cent, and no improvment in 4, or 10 per cent. In these 4 cases the disease was on the mucous membrane of the mouth or a verrucose form on the legs. Two severe cases of Duhring's dermatitis herpetiformis were permanently cured; these results must of course be tested on a larger material. Considerable improvement was attained in stubborn disseminated neurodermatitis, eczemas and essential pruritus. The treatments with this technique were very well borne. In only a few cases there was sweating and slight illness the next day.—*Audrey G. Morgan.*

Graninger, Karl. Aussichtsreiche Wege zur Heilung hoffnungsloser Röntgen und Radiumverbrennungen. (Method of treatment of severe roentgen and radium burns.) *Strahlentherapie*, 1930, *38*, 775–77.

A case is described in a man of fifty-two who was able to move his involuntary muscles voluntarily. He could displace his heart by voluntary contractions of the diaphragm. He had been repeatedly roentgenographed on this account and an enormous roentgen ulcer developed on his back. He had had the roentgen ulcer for twenty years when he developed carcinoma of the esophagus. As a result of the inanition from this condition the ulcer healed rapidly. The patient died after a gastrostomy.

The author believes that inanition, properly controlled by a physician of course, is a valuable treatment for severe roentgen and radium ulcers. It has been found of value in severe ulcers of the leg also.—*Audrey G. Morgan.*

Dautwitz, Fritz. Beitrag zur Radiumbehandlung der "blutenden Mamma." (Radium treatment of bleeding breast) *Strahlentherapie*, 1930, *38*, 710–718.

Some authors hold that bleeding breast is always a precancerous condition while others hold that it is only a symptom that occurs more frequently in benign than in malignant conditions. But there will always be patients who will refuse operation, even in malignant conditions Such cases and those in which the surgeon hesitates to operate because no definite tumor can be palpated should be treated with radium. The author describes 2 cases of papilloma irradiated with radium at distances of 1.5–3 cm. with heavy filtration (1.5 mm. lead) and the tubes in a cross-fire position. The patients were treated twelve and seventeen years ago and are still well. The left breast was affected in both these cases. Bleeding breast frequently shows a menstrual cycle and in the author's second case the bleeding recurred just before the period for several months after the irradiation. The doses given in these cases were 20,729 mg-hr. in five years and 26,950 mg-hr. in $3\frac{1}{2}$ years. Large doses were necessary to overcome the bleeding entirely. Smaller ones only stopped it for a time. In one case the bleeding recurred after it had stopped for two years, indicating regeneration of the papillomatous proliferations that had caused it. To prevent recurrence therefore radium treatment should be continued for a long time at rather long intervals. In one of these cases, in addition to the local effect, the radium stimulated metabolism and brought about a gain in weight. Two cases are cited in which exploratory excision showed malignancy but the patients refused operation. The tumors were held in check for eight and nine years. Hirsch in carcinoma of the breast extirpates the breast and a little of the surrounding normal tissue but does not extirpate the axillary glands; he treats them with radium. He has had extraordinarily good results in 22 such cases.—*Audrey G. Morgan.*

Simpson, Frank E. Radium in the treatment of hemangioma of larynx. *J. Am. M. Ass.*, Jan. 31, 1931, *96*, 342–344.

A review of the literature shows hemangiomas of the larynx to be rather rare. They are benign, usually congenital, but may appear at

any age, vary greatly as to size and extent of involved area and present the symptoms of any benign neoplasm, namely, hoarseness, cough and dyspnea. Small tumors may be removed; the danger of hemorrhage is great in surgical treatment of larger tumors and the use of radium is the only safe method of treatment. Two cases are reported in which large hemangiomas were treated by external and internal applications of radium emanation. There was satisfactory reduction in the size of the tumors with almost complete disappearance of symptoms and no recurrence after several years.—*E. W. Hall.*

Roffo, A. H. Resultados del tratamiento del cáncer de la matriz obtenidos en el Instituto en cinco años. (Results of treatment of cancer of the uterus obtained in the Institute during five years.) *Bol. Inst. de med. exper. (etc.)*, Buenos Aires, 1930, *7*, 768–774.

A total of 711 cases of cancer of the uterus was observed at the Medical Experimental Institute of Buenos Aires during a period of five years. Of these, only 3.2 per cent were operated on and 509 treated by radiation therapy.

The procedure was as follows: in the operable cases, preliminary irradiation was given first, this being followed by total hysterectomy; in the inoperable, radium or roentgen therapy, or a combination of both, was used. The results were about 70 per cent in the operable cases (28.1 per cent definite cure and 40.6 per cent still under observation); of the inoperable cases treated by radiation therapy, not one case has been cured. It must be mentioned, however, that the great majority of the latter group were exceedingly far advanced and that many were previously treated by radiation in some other hospital.

In conclusion, the author emphasizes the importance of the early diagnosis in cancer of the uterus.—*T. Leucutia.*

Forsdike, Sidney, Radium in gynaecology. *Canad. M. Ass. J.*, Dec., 1930, *23*, 792–797.

The author condones a paucity of knowledge of the action of radium on the tissues and the effect of various filters, etc. He reports on 181 cases of carcinoma of the cervix, treated by radium divided as follows: Inoperable cases, 134, of which none were cured; borderline case, 33, of which 4, or 12 per cent, were cured; operable cases, 14, of which 4, or 28 per cent, were cured. The rate of five-year cures in all cases treated was 4.5 per cent. The author, a surgeon, is definitely partial to radical removal in the operable cases. He does not give his radium technique. He makes no reference to having employed roentgen therapy externally.—*J. H. Vastine.*

Wintz, Hermann. Die wissenschaftlichen und experimentellen Grundlagen der temporaren Röntgenamenorrhoe. (The scientific and experimental foundations of temporary roentgen amenorrhea.) *Strahlentherapie*, 1930, *37*, 407–431.

From a discussion of the work that has been done on the subject the author concludes that temporary roentgen amenorrhea can be carried out with the certainty of a biological experiment. It is impossible to say just when menstruation will reappear as this depends on a number of individual factors. The time lies between one and three years. It will be possible to determine the time more accurately when a more accurate technique of dosage has been worked out. The avoidance of undesired permanent castration is also a question of technique of dosage and of further knowledge of the factors which influence the length of time for which sterilization is produced. But even now the percentage of successes is so great that the technique of temporary sterilization compares favorably with the technique for other medical procedures.

It may be considered definitely proved that temporary roentgen castration does not injure the woman; there is no injury of the skin and no psychic injury. No disturbances of the endocrine glands are brought about. The condition of the genital organs is not changed and neither libido or sexual pleasure are unfavorably affected. Roentgen amenorrhea therefore is a valuable therapeutic method.—*Audrey G. Morgan.*

Gauss, C. J. Die Klinik der temporaren Röntgenamenorrhoe. (Clinical study of temporary roentgen amenorrhea.) *Strahlentherapie*, 1930, *37*, 511–566.

The author discusses the clinical cases in which children have been born of irradiated mothers. He concludes that there is danger of injury of the fetus at any stage of a pregnancy if the fetus is irradiated directly in the uterus or indirectly by extragenital irradiation of the pregnant mother. For this reason pregnancy

should be excluded as definitely as possible before irradiating any woman. To avoid the danger of injuring the fetus at a stage when pregnancy is not yet demonstrable a curettage should be performed if possible before irradiation. If it is found after irradiation has been given that the woman was pregnant abortion should be performed.

The material available seems to show that there is danger of injury to the offspring if pregnancy occurs after the beginning of roentgen therapy and before amenorrhea begins. Therefore any patient who is to be irradiated should be warned of the danger to the child and told of the necessity for abstinence or prophylaxis. If pregnancy occurs within five months of the irradiation it should be ended by abortion.

But animal experiment and observation on man do not definitely prove that injury can take place later than that. As long as there is no proof of late injury it is justifiable to irradiate even women in the child-bearing age if the irradiation gives promise of improving or curing severe disease. The Würzburg clinic however holds the theory that there is danger of late injury and says that temporary roentgen sterilization should not be used except for women who are probably no longer capable of becoming pregnant on account of chronic disease of the adnexa, large myomas or endometriosis or for women who have dangerous diseases and in whom operation is impossible or contraindicated. Even with these limitations there are still many cases in which temporary roentgen sterilization is indicated. It will require further experiment and clinical observation to determine whether the indications can be widened. Every physician should keep his irradiated patients under observation and follow up the children and report any abnormalities.—*Audrey G. Morgan.*

HEALY, WILLIAM P. Treatment of carcinoma of the cervix uteri. *Ann. Surg.*, Jan., 1931, *93*, 451–459.

Previous to the discovery of radium and the subsequent recognition of its therapeutic qualities in the treatment of cancer, the only methods of treatment in vogue for cancer of the uterine cervix were those dependent upon surgical procedures. The most effective operative procedure was the Wertheim abdominal hysterectomy.

Bonney, who is probably the outstanding exponent of this plan today, shows a primary mortality of 16.5 per cent,—only in operable cases, and a five-year cure of 28.7 per cent.

Statistics presented by the author show that the absolute cure rate of all cases treated was 20 per cent as compared to 20.6 per cent from the Radiumhemmet, Stockholm, and the percentage cured of operable cases was 40.5 per cent compared to 40.4 per cent from the Radiumhemmet.

The author concludes that two-thirds of the cases are inoperable and not amenable to surgery and are best treated by radiation. Furthermore, there are more specialists qualified to treat carcinoma of the cervix properly with roentgen rays and radium than there are surgeons qualified to electively choose to do a radical Wertheim hysterectomy.—*F. K. Alexander.*

HEYMAN, JAMES. The combined radium and röntgen treatment of cancer of the cervix uteri. *Ann. Surg.*, Jan., 1931, *93*, 443–450.

The experience of recent years has taught that an effective radiological treatment is by no means a problem of dosage alone, in the sense that it is only a matter of applying the greatest possible radiation intensity to all layers of the tumor—though it is natural to assume that in some cases an incomplete cure in intragenital radium treatment must be due to an insufficient depth dose. One is led to this assumption by the fact that not infrequently the cervical tumor itself disappears after treatment while the cancer continues to invade the parametria and glands. A more efficacious irradiation of the parametria in these cases ought therefore to improve these results.

The introduction of deep roentgen therapy opened up new roads for parametric irradiation. In 1918, the Radiumhemmet began the combined roentgen and radium treatment of cervical cancer.

This paper gives in tabulated forms the types of cases treated and compares the results obtained in treating cervical cancer with radium alone and with radium in combination with deep roentgen therapy.

The author concludes that the combination of radium and deep roentgen therapy is superior as far as results are concerned. This is especially true in the inoperable case and it is questionable, whether, as yet, any conclusions can be drawn in the operable cases where clinically, the disease has not attacked the parametria.—*F. K. Alexander.*

Burnam, Curtis F. The treatment of cancer of the body of the uterus by radiation. *Ann. Surg.*, Jan., 1931, *93*, 436–442.

Cancer of the body of the uterus is, with rare exceptions, an adenocarcinoma and tends to metastasize more slowly than that of the cervix. Visceral and distant metastases are, however, much more common than in the epidermoid carcinoma of the cervix.

Old age and heredity are predisposing causes though it is rather difficult to prove the latter point on clinical material. There is a distinct tendency for these patients to develop cancer in some other part of the body of an entirely different type. Sterility and fibroids may also be predisposing factors.

In considering the treatment of this condition, the author divides the disease into early operable, late borderline and inoperable, the recurrent after operation, and the metastatic. In the operated group the author prefers radiation treatment as he believes that it offers a result comparable to surgery in permanent results and alleviates primary mortality and is applicable to a large number of patients who are bad surgical risks. The source of radiation used was radon in glass with 1 mm. of brass and 3 mm. of rubber. From 1 to 3 curies of radon were used, giving a dose of 2.5 to 3 gram-hours.

When the disease has extended beyond the uterus there is still definite hope for a cure by radiation followed later, perhaps, by operation.

A statistical study of the results obtained in different series reported in the literature follows the general discussion.—*F. K. Alexander.*

Floris, Michele. Esiti di lesioni infiammatorie del genitali femminili trattate con la Roentgenterapia. (Results in roentgen treatment of inflammatory lesions of the female genitalia.) *Radiol. med.*, Apr., 1931, *18*, 486–500.

Twenty-one cases of various diseases of the female genitalia are described which were given roentgen treatment. They included cases of metrorrhagia, menorrhagia, tuberculous and non-tuberculous adnexitis, gonorrheal vulvovaginitis, endometritis, pyosalpinx, puerperal parametritis and plastic pelvic peritonitis.

From his results the author concludes that roentgen treatment is very effective in inflammations of the female genitalia. Most of the cases were improved and some of them definitely cured. The action of the rays is both local and general. They not only have an immunizing and bactericidal action, stimulate the reticuloendothelial system and cause local hyperemia, but influence ovarian function; this effect may be direct or indirect through action on other endocrine glands.—*Audrey G. Morgan.*

Gordon-Watson, Charles. How far can radium replace radical surgery for cancer of the rectum? *Ann. Surg.*, Jan., 1931, *93*, 467–475.

It is generally recognized that radical surgery for cancer of the rectum in the early stages cures a very high percentage of those who recover from the operation but it involves the stigma of colostomy.

Dukes has shown that lymphatic invasion does not occur until the growth has penetrated through the longitudinal muscular coat of the bowel. Ulceration indicates rapid downward spread and early penetration of the muscular coat, so that the actual size of the growth is not a sure test of suitability for local resection.

Early growth of the rectum can be destroyed with radium without colostomy and without interference with the functions of the rectum, though no five-year observations are available as regards recurrence. All growths are regarded as operable in the absence of metastases in the peritoneum or liver, provided that the rectum can be removed with the surrounding lesions and all invaded lymphatics clear of the growth, and provided that the rectum is not fixed to the bladder, sacrum or pelvic wall by malignant infiltration. Though in most instances a good case cannot be made out for radium in the early case in preference to modified radical surgery, there is much more to be said for it as it approaches the borderline where a radical cure from radical surgery becomes more uncertain and the operative risks increase.

The fibrosis resulting from irradiation is well known and whether or not a stricture results depends upon the amount of radiation given and the care given to the case during convalescence.

A small growth in the rectum below the peritoneal reflection in the female can be attacked through the vagina if it involves the anterior or lateral walls. In the male the best approach is from behind after removing the coccyx. The author prefers seeds to needles as the seeds can be left in situ.

The author, from his experience, thinks that radium offers the best chance of a cure in patients under thirty. This chance for a cure is also greater in cases of squamous cell carcinoma. He also believes that in cases of adenocarcinoma

below the peritoneum, experience has shown the results to be anticipated are too uncertain to justify preference for radium over surgery unless surgery is contraindicated.

Incomplete knowledge and limited experience of the action and use of radium have to be balanced against a standard of surgery which seems to have reached its zenith.—*F. K. Alexander.*

Frangella, Alfonso C. Nouvelles orientations thérapeutiques de la radio-émanation. (New therapeutic indications of radium emanation.) *Rev. sud-am. de méd. et de chir.*, Dec., 1930, *1*, 1267–1268.

During the past three years radium emanation in solution was used rather extensively at the Radiological Institute at the University of Montevideo. Of 12 cases of leucemia treated with intravenous injections of radium emanation, 7 have survived for three or four years, remaining in good general condition. In 12 cases of Hodgkin-Sternberg's disease, the results were likewise favorable. During the course of the treatment of these latter, it was observed that the radium emanation was well supported in rather large doses given at once. Moreover, the affected tissues which have become radioresistant to roentgen rays or the gamma rays of radium have become sensitized, thus making further irradiation possible. Lately the impression was gained that a combination of intravenous radium emanation and roentgen therapy leads to better results than either of the methods alone. In such instances the injection of the radium emanation is carried out with doses of 10 to 20 mc. weekly, a series of 10 injections being given before and after the irradiation.

Surprisingly good results were obtained in 8 cases of exophthalmic goiter and hyperthyroidism. Thus a weekly intravenous injection of 6 to 8 mc. led to complete disappearance of the symptoms with normal basal metabolism in all early cases. In the chronic or recalcitrant cases a combination of the radium emanation with other therapeutic methods proved of greater value.

Good results were obtained also in 14 cases of gout, the radium emanation having been administered intravenously, orally, or by inhalation.

Taken as a whole, the impression is gained that the use of radium emanation in solution is of great therapeutic value in certain well-selected cases.—*T. Leucutia.*

St. Graur, Emil. Consideraţiuni asupra tratamentului radiological fibromioamelor uterine. Rezultatele obţinute in Institutul de Radiologie din Cluj, in decurs de opt ani. (Considerations on the radiologic treatment of uterine fibromyomas. Results obtained at the Radiologic Institute of Cluj during the past eight years.) *Cluj. med.*, April, 1931, *12*, 219–228.

Following a detailed discussion of the classification and clinical appearance, as well as of the indications, contraindications and technique of irradiation (both with roentgen rays and radium) of uterine fibromyomas, the author publishes the results obtained at the University of Cluj during the past eight years. A total of 129 cases was treated, chiefly with roentgen rays, using generally the following factors: 4 fields (in stout patients 5 or 6 fields), 10×14 cm., 23 to 30 cm. skin target distance, 3 ma., 180 kv., 0.5 mm. Zn plus 4 mm. Al as filters, a full erythema dose being administered over each field in one sitting, one field being treated daily for four to six days. Good results were obtained in all cases except 3 (26 cases could not be traced). Amenorrhea followed in the majority of instances after one or two menstrual periods (more rarely after three or four periods), and lasted from one to eight years. In 25 cases the tumor disappeared entirely; in 32 it decreased to one-third and in 43 to one-half of the original size. The reaction from the treatment was, as a rule, very slight and the post-climacteric changes were quite insignificant, except in one case which required temporary hospitalization, the symptoms disappearing later.

The conclusion is reached that roentgen therapy is a very valuable curative agent in the treatment of fibromyomas of the uterus.—*T. Leucutia.*

Remy-Roux. La radiothérapie pénétrante dans les fibromes utérins et les hémorrhagies de la ménopause. (Penetrating radiotherapy in uterine fibromas and hemorrhages of menopause.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1931, *19*, 192–196.

A total of 159 cases of the above-mentioned conditions were treated by the author with roentgen therapy by using the following tech-

nique: 200,000 volts, 1 mm. Cu plus 2 mm. Al as filters, 4,000 R given in four seances of 1000 R each, at two day intervals, the dose being exceptionally increased to 6,000 R given in six seances. In a limited number of cases, if the regression of the tumor was slow, an additional dose of 2,000 R in two seances was administered three months later. In all instances very satisfactory results were obtained.—*T. Leucutia.*

ZWEIFEL, ERWIN. The present status of the treatment of carcinoma of the cervix uteri. *Am. J. Obst. & Gynec.*, Nov., 1930, *20*, 595–606.

The author states that the results in the best published statistics on treatment by irradiation are about the same as the results in the best published statistics for surgery.

The advantages enjoyed by irradiation are the absence of fear in the patient, resulting in earlier treatment; the low immediate mortality; its value in both operable and inoperable cases; the constant advancement and improvement in technique while surgery has reached a status quo. The disadvantages of irradiation are the complications which may result even with the most careful technique just as in surgery, or inadequacy of the treatment. "Proficiency in radiation therapy is more difficult to achieve than proficiency in surgery."

The treatments available are surgery, irradiation, or a combination of the two. Radiation therapy should always have a definite place in the plan of treatment for uterine carcinoma. The value of irradiation is conclusively demonstrated in the statistical reports of various authorities in which their cures were doubled by routine postoperative irradiation over their cures by surgery alone. This includes reports by Krönig and Gauss, Warnekros, Zacherl and Lundwahl, Adler, Breitschneider, Giesecke, Lehotsky-Semmelweiss, and many others. The value of routine postoperative irradiation in carcinoma of other structures as the ovary, breast, etc., have been conclusively demonstrated by Seitz and Wintz, Eymer, Franque, Jaschke, Strassmann, Schaefer, Breitschneider, Flatau, Auburt, E. Zweifel, Meyer, Bucholz, etc.

Stoeckel combines preoperative radium therapy, radical surgery and postoperative roentgen therapy.

The author, a gynecologist, concludes that surgery and postoperative irradiation combined give better results than surgery alone. The relative value of surgery and radium is not determined.

The discussions by Ward, Brettauer, Mikulicz, Healy, Stone, McGlinn, Taussig, Farrar and Zweifel are well worth reading.—*J. H. Vastine.*

BARRINGER, BENJAMIN S. Carcinoma of the prostate. *Ann. Surg.*, Jan., 1931, *93*, 326–335.

The author presents this paper in an attempt to analyze the reasons for failure in the past in treating carcinoma of the prostate, to discuss present ideas on the subject and to suggest further improvement in the control of the disease by radiations.

The protean forms of the disease, lack of definite symptomatology, and the simulation of benign disease make early and accurate differential diagnosis difficult. The age incidence is of little help in diagnosis as both malignancy and benign hypertrophy run nearly parallel for each age group. The initial symptoms of carcinoma of the prostate fall into two main groups: (1) urinary symptoms; (2) pain. The former are usually the first observed by the patient and therefore the most important from the point of view of early diagnosis. The three most common are frequency, difficulty of urination and nocturia. The symptoms of pain which bring the patient to a physician are, in the order of importance, painful urination, backache, pain down thighs and legs, pain in the lower abdomen and pelvis, and in the hips, groin, penis, rectum and perineum. These conditions are caused by direct extension to the bladder neck, to pressure on nerve trunks, or to distant metastases, especially to the bones.

In the series of 280 cases to which the author refers, he reports an average elapsed time of twenty-four months between the appearance of the initial symptom and first consultation. Because of this point he pleads for careful and early attention to all symptoms relating to the urinary tract and further stresses the importance of routine examination of the prostate in all men over fifty years. The difficulties of accurate diagnosis of prostatic neoplasms have been considerably decreased by the adoption of biopsy by needle puncture and aspiration. This is used as a routine procedure in all cases except those going to operation.

The author states that a tissue dosage of

somewhere between 10 and 15 skin erythema doses delivered to the tumor is necessary to control the large majority of prostatic carcinomas. As this cannot be delivered externally it becomes necessary to deliver the bulk of the total dose interstitially, and the author recommends that cystotomy should be done and the entire tumor implanted with radon seeds of 2 millicuries each to every cubic centimeter of growth.—*F. K. Alexander.*

Hayden, E. Parker, and Shedden, William M. Carcinoma of the rectum. *Surg., Gynec. & Obst.*, Dec., 1930, *51*, 783–789.

This is an analysis of 303 cases from the Huntington Memorial Hospital of Boston.

Cancer of the rectum and sigmoid comprises about three-fourths of the malignancy of the intestinal tract.

Etiology. No definite relation can be traced between hemorrhoids, constipation, fistula, etc., and carcinoma. Adenomatous polyp is the most dangerous predisposing factor in the development of rectal adenocarcinoma.

Age. Greatest number of cases occurred in the fifth decade. The youngest was eighteen years of age and the oldest was ninety-two.

Family history of carcinoma was obtained in only 7 per cent of 177 cases in which there were sufficient data.

Pathology. Malignant adenomata of a low grade malignancy comprised 57 per cent of the cases. Adenocarcinoma of Grades 1 and 2 comprised another 28 per cent. Epidermoid carcinoma comprised 9 per cent of the cases. Sarcoma and lymphoma are rare. The authors recommend preliminary biopsy to determine the type of malignancy and the course to follow.

Symptoms and Diagnosis. The diagnosis is made from a careful history, digital examination, speculum and proctoscopic examination and barium enema; 95 per cent of their cases occurred within 10 cm. of the anus and were therefore palpable with the finger. Rectal pain, tenesmus, bleeding and alteration in the character of the stools were the most frequent symptoms.

The authors stress the delay in consulting their family physician and the subsequent delay before the family physician recognizes the condition. They advise periodic health examinations.

Treatment. Complete surgical removal is advised and attempted in all operable cases; 77 per cent of the rectal cases are of a low degree of malignancy and hence are radioresistant. Irradiation is used only in the inoperable cases or those in which operation is refused. Sampson-Handley and others feel that there is reason to hope that ultimately operative procedures on carcinoma of the rectum will be abolished by improvements in radium technique. Neumann and Coryn make an incision around the anus and free the rectum from its attachments so that radium needles can be inserted into the growth externally. Lockhart-Mummery uses a similar technique of interstitial needling. The authors agree with Carter Baines that intracavitary application has failed deplorably except in conjunction with other methods.

Hayden and Shedden in the earlier cases used surface applications which were later replaced by glass seeds and still more recently by gold seeds used interstitially. The gold seeds have been employed for too short a time to warrant a statement as to results but they feel encouraged to persist in their use. In the cases in which irradiation was employed, radium alone was used in 88 per cent of the cases. The authors do not state their reason for not employing roentgen rays in addition to the interstitial irradiation. There were 29 operable cases in which radium was employed and of these 24 are dead from carcinoma. The living cases are of questionable malignancy. There were 63 cases in which a radical operation was performed and of these 21 are still living, 14 of them being for periods of over five years. It must be remembered that only the most favorable cases were operated upon.—*J. H. Vastine.*

Colaneri. Au sujet de la lymphogranulomatose viscérale. (Concerning visceral lymphogranulomatosis.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1931, *19*, 152–156.

In discussing the response of visceral lymphogranulomatosis to radiation therapy, the author emphasizes two points: (1) the persistence of cough in case of mediastinal tumefactions even after complete disappearance of the tumor mass (this being observed in 3 cases), and (2) the non-recurrence of the lesion within the treated area if the irradiation was carried out in satisfactory conditions. It is probable that both of these phenomena are the result of sclerosis of the lymph nodes or tissues brought about by irradiation. This suggests that penetrating roentgen therapy with massive doses admin-

istered, section by section, over the entire body is the best method of treatment to be followed. —*T. Leucutia.*

MISCELLANEOUS

Müller, Erich H. Zur Frage der Zeitkontrolle im medizinischen Röntgenbetrieb. (On the question of time control in medical roentgen service.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1930, *42*, 657–663.

The author describes and illustrates with photographs and diagrams three practical roentgen timers which at the same time graphically register the duration of the exposure. The first timer is used for therapeutic purposes the registration being done on a paper disc. The second timer is devised chiefly for the control of the time of exposure in roentgenoscopy and is made in the form of a buzzer which signals every minute, the signal growing longer each time and finally changing, after the lapse of six minutes, into a continuous buzz. The third timer, which is called the electro-recorder, indicates at what time and how long the roentgen apparatus was in operation.—*T. Leucutia.*

Wilhelmy, E., and Wolodkewitsch, N. Ein neues Gerät zur Herstellung gezielter Röntgenmomentaufnahmen. (A new device for making centered instantaneous roentgen exposures.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1930, *42*, 769–778.

The authors devised a new method for the taking of roentgenograms on fluoroscopic units without change in the setting. For this purpose they constructed an apparatus which can be connected to any roentgen machine permitting an automatic change from fluoroscopy to roentgenography. The apparatus consists of a hot cathode electronic tube with a special grid arrangement which acts as a relay during fluoroscopy. Thus the roentgen machine is set for the factors used in roentgenography and while the fluoroscopic examination is made the electronic relay is thrown in. The electronic tube being in the circuit of the filament current, it will reduce the intensity of this to that generally used in fluoroscopy. As soon as the roentgenoscopic examination is completed and the roentgen ray centered over the area to be roentgenographed the cassette containing the film is put in place, this automatically disconnecting the electronic relay and thus reëstablishing the factors necessary for roentgenography.

The apparatus is described in lengthy detail and illustrated with several diagrams and photographs. Its use has proved of great value in the study of the border of the heart and of the esophagus in various phases of deglutition, permitting an instantaneous change from roentgenoscopy to roentgenography.—*T. Leucutia.*

Castellino, Pietro G. L'azione dell'irradiazioni roentgen ed ultraviolette sil sistema reticolo, istiocitario cutaneo. (The action of roentgen and ultraviolet rays on the reticulo-histiocytic system of the skin.) *Arch. di radiol.*, 1930, *6*, 681–689.

Since Aschoff's description of the reticulo-endothelial system, the system has been enlarged to include other cells than those described by him and Volterra proposes calling it the reticulo-histiocytic system. A number of diseases have been attributed to changes in this system, including granuloma, hemolytic anemia, lymphatic diathesis, lipemic diabetes, xanthoma, xanthelasma, pigmented urticaria, Schamberg's progressive melanosis and mycosis fungoides.

In the skin the reticulo-histiocytic system is not very prominent. It is made up of three types of elements: reticulate tissue of very delicate interlaced fibers which follows and surrounds the blood vessels and lymphatics, tissues of a stellate type with basophile nuclei, round or oval, connected with each other by dendritic processes and located at the intersecting points of the reticulate fibers and cells of a histioid type of various shapes and sizes scattered among the connective tissue fibers.

The author irradiated adult guinea pigs with roentgen and ultraviolet rays in order to determine the effect of the rays on this reticulo-histiocytic system of the skin, after having brought about vital staining of the system with trypan blue. Ultraviolet rays had very little effect. Small doses of roentgen rays did not have much effect, moderate ones caused an increase in the number of histiocytic cells and a slight increase in the reticulate cells. The histiocytic cells were full of granules. In the papillary zone there were some Langhans' cells and some fibroblasts stained blue. Evidently from the increased number of cells and the increased number of granules in them the rays have a stimulating effect on the reticulo-histiocytic system. The presence of fibroblastic cells may also mean that there has been an abnormal awakening of cells normally at rest and that functional and anatomical changes in these cells may cause atypical proliferation.—*Audrey G. Morgan.*

Ko Muro-Hide o. Mikrochemische und zytologische Befunde an röntgenbestrahltem Pflanzengewebe. II. Unterschiede zwischen dem "Naturtod" (Altersschwächetod) und dem Röntgenbestrahlungstod in den Wurzelspitzen von Vicia faba. (Microchemical and cytologic findings in plant tissues irradiated by roentgen rays. II. Difference between "natural death" (death from old age) and roentgen-ray death of root points of *Vicia faba*.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1930, *42*, 763–769.

The author investigated by means of microchemic reactions (staining with various dyes) the difference between the natural and roentgen death of the root points in three species of *Vicia faba*. The technique of irradiation was as follows: French Coolidge tube, molybdenum anticathode, 40×10^3 v., 5 ma., $5\frac{1}{2}$ a. Coolidge filament, 20 cm. skin target distance, two 1-hour exposures at 46 hours 54 minutes interval.

It was found that the chief characteristic of the natural death of the plant roots was a karyolysis due to vacuolization of the cytoplasm as a result of the longitudinal growth of the roots. In the irradiated material the changes in the tissues near the vegetative points were identical to those observed in death from old age, but in the tissues distant from the vegetative points, an active growth of the cells with mytotic nuclei could be observed. This is exceedingly important from the point of view of tumor pathology since it indicates that tissues of old age may lead to active proliferation of the cells resulting in neoplastic tumors.—*T. Leucutia.*

Roffo, A. H., and Degiorgi, H. Variaciones del CO_2 en relación con la reacción de Roffo y los rayos Roentgen. (Variations of the CO_2 in relation to the Roffo reaction and the roentgen rays.) *Bol. Inst. de med. exper. (etc.)*, Buenos Aires, 1930, *7*, 775–339.

There is an increase of CO_2 in the serum of patients subjected to irradiation. This, however, is not in relation to the modifications occurring in the Roffo reaction before and after treatment but is most probably the result of the altered metabolism during the period of cachexia and the duration of the reaction.—*T. Leucutia.*

Squirru, C. M. La pomada de Rojo Neutro del profesor Roffo en el tratamiento de heridas, úlceras, limpieza de tumores, etc. (The neutral red salve of Roffo in the treatment of wounds, ulcers and cleansing of tumors, etc.) *Bol. Inst. de med. exper. (etc.)*, Buenos Aires, 1930, *7*, 765–767.

Based on an experience of thousands of cases, the author recommends the application of neutral red salve according to the formula of Roffo (2 per cent) for wounds, ulcers and sloughing tumors, as well as radium and roentgen dermatitis. This salve, apart from its cleansing effect (the neutral red precipitates the proteolytic enzyme) acts also as a deodorant.—*T. Leucutia.*

Roffo, A. H. Viraje de la eosina por las irradiaciones Roentgen. (The change of color of eosin produced by roentgen irradiations.) *Bol. Inst. de med. exper. (etc.)*, Buenos Aires, 1930, *7*, 5–10.

Roentgen rays change the color of eosin in $C\,Cl_4$ solution from red to bright yellow, the hue depending on the intensity of the radiation. The effect is indirect through liberation of Cl which after uniting with H acts in the form of HCl on the eosin replacing two atoms of Na in its structure.

The article is illustrated with several colored plates showing the various degrees of change in color.—*T. Leucutia.*

Roffo, A. H., and Degiorgi, H. La función ácida en la transformación de la colesterina por los rayos Roentgen en el suero sanguíneo. (The function of acid in the transformation of cholesterin of the blood serum by roentgen rays.) *Bol. Inst. de med. exper. (etc.)*, Buenos Aires, 1930, *7*, 292–297.

Quantitative examinations revealed that the decrease in the amount of cholesterin of the blood serum due to the effect of roentgen rays is not followed by any variation of the CO_2 content. This indicates that the destruction of cholesterin is not associated with a decomposition of the bicarbonates of the blood serum. The effect must therefore be sought in the action of the roentgen rays upon other substances which will form the subject of future investigations.—*T. Leucutia.*

Siciliano, L., and Banci-Buonamici, C. Studi sul midollo osseo sotto l'azione dei raggi X. (Study of the bone marrow under the action of roentgen rays.) *Arch. di radiol.*, Nov.–Dec., 1930, *6*, 1108–1136.

Experiments are described in irradiating the bone marrow in guinea pigs. The irradiated

bone marrow showed changes quite early, consisting of degeneration of the specific cells of the hematopoietic system and after a certain time their disappearance. These changes affected the white cells as well as the erythrocytes. The white cells changed sooner and more intensely than the reds and the red cells seemed to have a greater capacity for regeneration after the irradiation was over. Even on irradiation with small and repeated doses which cause an increase of red and white cells in the circulating blood, the histological findings in the bone marrow always showed degenerative changes. Examination of the bone marrow at a distance from the irradiation showed changes in the morphology and distribution of the cells. The megakaryocytes showed quite serious changes in the nuclei, the percentage of immature red cells was markedly increased, the red cells predominated over the whites and the polymorphonuclears were greatly decreased in number, though if the doses were small both these and the myelocytes remained normal.

These changes occur, with some variations, no matter what the dose used and what the zone irradiated, no matter whether it is one paw or the ears or the whole body except one paw, though in the latter case the changes are more intense and there is a very great increase in the myeloblasts.

These changes are not in proportion to the changes in the circulating blood, so no conclusions can be drawn in regard to the condition of the blood from examination of the bone marrow. If the circulation in the irradiated limb is interrupted during the irradiation, the direct effects on the bone marrow are less severe and there is also less action at a distance, probably because less of the toxic products enter the circulation. The indirect action on the hematopoietic system on local irradiation is of preponderant importance. This is of great importance in the mechanism of treatment of blood diseases, as it makes it possible to act on the whole hematopoietic system with local applications of rays which it would be practically impossible apply to the whole diseased area.—*Audrey G. Morgan.*

Menville, Leon J., Ané, J. N., and Blackberg, S. N. Observation on the motility of the gastro-intestinal tract of starving rats. *Proc. Soc. Exper. Biol. & Med.*, Dec., 1930, *28*, 249–250.

The experiments were made on normal, healthy rats that were gradually deprived of food over a period of three weeks, with no restriction as to the intake of water. This series consisted of 5 rats averaging 243 gm. in weight. They were at first made to fast for twenty-four hours and subsequently each rat was fed 2 gm. of normal food per day for twenty-one days. All of the rats lost weight, the average weekly loss being 54 gm. (2 of these rats died within 15 days). The remaining rats of this series on the 21st day of starvation were fasted and deprived of water for twenty-four hours and then fed a 10 gm. mixture of 3 parts buttermilk and 1 part barium sulphate. They were permitted to eat this for twenty minutes and immediately fluoroscoped to ascertain if the stomach was filled. The observations were continued every fifteen minutes until the stomach and small intestines were found empty. The examination of the colon was made at longer intervals. Three normal rats were included in the observations. These had a normal intake of food for the first twenty-one days and then were treated like the experimental group.

In every one of the 3 starving rats a marked hypermotility was observed of the entire gastrointestinal tract. It was found that the passage of buttermilk plus barium sulphate through the entire gastrointestinal tract was very much faster in the starving rats than in the controls. —*B. Cohen.*

Spinnelli, A., and Talia. Ipofisi e callo osseo; ricerche sperimentali. (Experimental study of the effect of irradiation of the hypophysis on the formation of bone callus.) *Arch. di radiol.*, 1930, *6*, 748–762.

The authors fractured the limbs of dogs and then treated them by irradiation of the hypophysis. The protocols of the experiments are given and the article is illustrated with roentgenograms. They found that irradiation of the hypophysis with a stimulating dose causes early formation of the callus and more rapid development than in cases without irradiation; there is more active formation of osteoblasts and greater thickening of the periosteum. On irradiation with an inhibiting dose the callus formed late and developed slowly.—*Audrey G. Morgan.*

Frank, Josef. Ein absolutes Hochspannungselektrometer für die Praxis. (An absolute

high tension electrometer for the practice.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1930, *42*, 751–762.

The author constructed an absolute electrometer for the practical measurement of the high tension. The apparatus is based on the principle of the Kirchhoff balance, the attraction produced by the high tension being balanced against the force of gravity of measuring weights. Thus, one pan of the balance is replaced by a metal plate (surrounded by a carefully constructed protective ring) which is at a definite distance (in the author's measurements either at 3.8 or at 12 cm.) from a second plate serving as the one pole of the high tension circuit. The other pan contains the measuring weights.

Similar balance electrometers have been constructed before but they all had the great disadvantage that every single measurement of the tension necessitated painstaking balancing of the weights. In the author's procedure the weighing is done only with whole grams, accurate tables of the voltage values being furnished for every gram for both the plate distances of 3.8 cm. and 12 cm. The weighing of the fractions of the gram is replaced by a scale system mounted on the top of the extremity of the beam from which the electrometric plate is suspended. This consists of a suspension arrangement of aluminum foils with a mirror (similar to that used in galvanometers). An upward deflection of the balance relieves the distention of the aluminum foils leading to a deviation of the mirror on a graduated scale (a scale from 0 to 50 being equivalent to 1 gram weight). An example will best illustrate the method of procedure: If one has to measure a voltage of about 170 kv. a consultation of the table shows that 15 gm. (12 cm. plate distance) is equivalent to 166.3 kv. and 16 gm. to 171.7 kv. One will therefore place in the pan 15 gm. and proceed with the measurement. If the mirror indicates, for example, a deviation of 25 (half of the scale) one must take the half-value between 166.3 and 171.7 kv., that is, 169 kv., which is the absolute value of the tension measured.

The apparatus is described in lengthy detail and illustrated with diagrams and photographs. Various tables expressing the volts in equivalent weights are also included. The apparatus is made by Richard Seifert & Co., of Hamburg. According to the author's estimation the method has an error of only 1 per cent.—*T. Leucutia.*

Sievert, Rolf M. The methods for testing radium preparations used by the physical laboratory of Radiumhemmet, Stockholm. *Acta radiol.*, Dec. 31, 1930, *11*, 649–657.

This article contains a description of instruments and methods in use at the Physical Laboratory of Radiumhemmet for testing radioactive preparations of greater activity than 0.1 mg. radium element. Three principal tests are made for this purpose at the laboratory, namely, for detecting any leakage of emanation that may occur, for determining the amount of gamma activity of the preparation measured in milligrams of radium element and for ascertaining what radioactive substances are present in the preparation. Special instruments have been devised for these tests and have proved effective. Radiumhemmet issues certificates based on the results obtained by the tests.—*Audrey G. Morgan.*

Wright, R. S. Thermionic rectification of x-ray circuits. *Brit. J. Radiol.*, Aug., 1930, *3*, 369–374.

The author describes the connections used in a four-valve circuit of the usual type.

He gives emphasis to the factor that a valve tube may give off rays, stating that this danger can be corrected by passing enough current through the filament of the valve, and further, if the saturation current of the x-ray tube is less than that of any of the valves.

In allowing for the necessary margin of safety there are two possible sources of danger: the first, an unforseen voltage drop in the main supply, cooling the valves and filaments and therefore decreasing the "saturation" limit, and the second, a gradual wasting of the filaments by time.

The author states that a single valve plant can be made as powerful as four-valves providing the current is doubled. This makes for a considerable overloading of the transformer with resulting inefficiency due to voltage drop. —*F. K. Alexander.*

Bell, G. Eric. The emission of x-rays by rectifying valves. *Brit. J. Radiol.*, Aug., 1930, *3*, 364–368.

There is no essential physical difference between valve and hot cathode-ray tubes. The fundamental difference between the two lies in the way they are used. If we construct a curve showing the relation between the current

through the tube and the potential difference between its electrodes it always has a certain constant arc up to a certain point. When the potential is increased the curve continues to rise, though more slowly, and finally gradually approaches a limiting valve. Such a curve is known as the "characteristic curve" of that tube. The maximum limiting current on the curve is known as the "saturation current."

The fundamental difference between an x-ray tube and a valve is the point on the characteristic at which they are marked. The former is always operated indefinitely near its saturation value, while the value should always be adjusted so that the maximum current is less than saturation current.

A formula of known value was extrapolated for a valve tube used in experimental purposes and it was found that at a current within 10 per cent of saturation current the voltage across the valve was approximately 2,000 volts, negligible as far as the production of roentgen rays is concerned. There is not a great deal of latitude, however, and as saturation is approached the voltage across the valve rises rapidly and becomes comparable to the voltage across an x-ray tube.

The saturation current can be greatly increased by slightly increasing the temperature of the valve filament.

From the above it is clear that, so long as the maximum current passing through the valve is less than saturation current of the valve, the valve is a safe and efficient piece of apparatus. If the maximum current approaches very near to the saturation value the valve becomes dangerous because it emits roentgen rays, and inefficient, because there is a large voltage drop across it.—*F. K. Alexander.*

Schall, W. E. The advantages of valve rectification. *Brit. J. Radiol.*, Jan., 1930, *3*, 24–37.

The author describes by designs the usual hook-ups of the mechanical and valve tube rectifiers.

He gives the following advantages of valve tube rectification.

(1) The application of the principle of current suppression, where only a valve can be used. An example of this is in the so-called "Villard" connection, which allows with the help of two condensers and one valve to achieve a duplication of the kilovoltage which a transformer secondarily supplies.

(2) Noiselessness and no moving parts requiring care.

(3) The third point in which the valve excels, is on the score of resistance. A properly heated valve presents to the oncoming current, a resistance such that there will be a voltage drop not exceeding 3,000 volts across the gap from cathode to anode. In a four valve unit there are always two valves in circuit at any moment and there is therefore a voltage drop across them, not exceeding 6,000 volts. In the mechanical rectifier the voltage drop across each spark gap is of the order of 7,000 and as there are always two spark gaps in circuit at any moment, the drop in volts is 14,000, that is to say, more than twice what is the case with valves.

(4) The current passes through the valves smoothly in contradistinction to the mechanical rectifier where the combination of the high induction of the secondary, the high electrical capacity of the system and the two sparks makes for the undesirable surges which are able to do a lot of harm.—*F. K. Alexander.*

Failla, G. A new instrument for measuring x-radiation. *Radiology*, Oct., 1930, *15*, 437–447.

A new type of roentgen-ray measuring instrument is described, in which use is made of the well-known balance or compensation method of measurement. A vacuum tube device is used as the "balance detector." An ionization chamber containing a small amount of radium is used as the "compensator." The instrument possesses several distinct advantages. Extremely high electrical insulation is not necessary. The length of the cable joining the ionization chanber to the measuring device proper does not influence the readings, therefore a long flexible cable can be used, permitting the observer to be in a separate room at any desired distance from the roentgen machine. The instrument can be calibrated to read directly in roentgens per minute (no stop watch being required). It has a wide range, permitting the measurement of roentgen beams of very different intensities. It has a high sensitivity combined with stability and ruggedness. The use of radium or other long-lived radioactive material in the compensating ionization chamber insures an unusual permanence of the calibration. No delicate apparatus is embodied in this instrument. The vacuum tubes and other "radio" parts used can be replaced without affecting the calibration of the instrument. These parts are readily

obtainable throughout the country. Simplicity of operation is also an advantage.

A new ionization chamber is described briefly in this paper. It permits the determination of the roentgen-ray beam intensity directly in roentgens per minute without previous calibration, over a considerable range of hardness. A potential of a few hundred volts is sufficient to produce saturation in this chamber with all practical beam intensities. The measuring device proper is capable of determining the magnitude of a very small, unidirectional, electric current. Accordingly it may be used to measure anything which can be made to produce an electric current. In addition to roentgen rays, by suitable accessories it can measure (1) radioactive substances and their radiations, (2) visible light, and (3) ultraviolet light.

The instrument described in the paper has passed the experimental stage and has been in actual operation for a considerable time. Its practical utility has been definitely established by Failla at the Memorial Hospital, New York. —*J. D. Camp.*

Mutscheller, A. Quantum energy of x-rays: a new method of measuring it. *Radiology*, Oct., 1930, *15*, 460–467.

A new method of measuring experimentally the quantum energy in ergs of roentgen radiations produced at various voltages is described. A method of testing dosimeters, i.e., ionization chambers used for intensity measurement, for their dependence or non-dependence on wave lengths, is also given. It is pointed out how the clinical aspect of radiation therapy can be simplified by the application of the quantum principle, and that in all probability the clinical effects of roentgen radiation run parallel not with the total ionization effect, the wave lengths, or the absorption coefficients, but with the quantum energy and the total number of the quanta. In view of the facts outlined, it is suggested that clinical radiation data and especially quality measurements be made and recorded in terms of quanta energy or ergs.—*J. D. Camp.*

Niemann, Carl. Das Messen der Röhren—und Apparatespannungen. (The measurement of the tensions of the tube and apparatus.) *Fortschr. a.d. Geb. d. Röntgenstrahlen*, Oct., 1930, *42*, 519–526.

The tensions of the roentgen apparatus do not have as a rule a strictly sinusoidal form. For this reason, the peak, effective and arithmetic values do not show a constant relation which could be easily calculated.

For practical purposes the following procedures are advised: (1) The measurement of the primary voltage of the high tension transformer, although containing certain errors, gives a good effective value of the high tension voltage.(2) The spectrographic method measures the peak value while the current is flowing through the tube. (3) The sphere gap gives the peak value regardless of whether there is current flowing through the tube or the tube is disconnected.—*T. Leucutia.*

Sievert, Rolf M., and Benner, Sven. On secondary β-rays from the surface of radium containers. *Acta radiol.*, Aug. 15, 1930, *11*, 303–309.

This article contains the preliminary results of an investigation of the secondary beta-radiation emitted from the surface of medical radium preparations. As these rays are absorbed by a few millimeters of the tissue and under certain circumstances may amount to 50 per cent or more of the total dose, the great importance of this factor both in intubation and distant treatment is pointed out. By collating the physical constants of this beta radiation it is shown that the amount of secondary radiation may be considerably reduced by the choice of a suitable filter material. The authors think it important that further investigation of the problems involved should be undertaken with more suitable apparatus, so as to determine more accurately what advantages might result from changing to some other filter material than platinum which is now in general use. They are carrying on investigations with preparations of the same shape but contained in different substances and an electromagnet specially designed for the purpose. The results will be published later in this journal.—*Audrey G. Morgan.*

Schechtmann, J. Die Anwendung des Aspirationsgeräts nach Ebert zur Prüfung des Röntgenschutzes in den Röntgenabteilungen. (The use of Ebert's aspiration device for testing protection in roentgen departments.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1930, *42*, 645–650.

The aspiration device of Ebert consists of an electrometer connected with a condenser through which the ionized air to be measured is driven

by means of a strong turbine. Thus, the apparatus really constitutes a giant ionization chamber, the volume of the air passing through it being equal to the volume of the air of the examining room. The ionization value is determined according to the following formula (the volume of the air being measured by means of an anemometer):

$$N = \frac{C \cdot V}{300 \cdot M \cdot E}$$

in which N is the number of ions, C the capacity of the system, V the drop of potential in volts, M the volume of the air, and E the ionic charge.

In making a series of experiments the author found that Ebert's device can be used advantageously for the measurment of the ionization in the roentgen rooms inasmuch as it has a very high sensitivity. Thus, a roentgen intensity yielding a dose of 0.5 to 1.0 r per month can be easily measured. The following experimental findings are of practical importance: Even with the best protection (as, for example, in deep roentgen therapy rooms) the ionization of the air is two to three times greater when the tube is in operation than when the tube is disconnected. If the protection is poor the ionization of the air may reach a value as high as 30,000 to 60,000 ions per 1 c.c.

The steel concrete ceilings give a sufficient protection against the direct and scattered roentgen rays but the wooden ceilings are insufficient. In roentgenoscopy a protection of the neighboring rooms against scattered radiation is not necessary if a sufficient protection against the direct rays exists.

The author considers as "tolerance dose" an amount of radiation which is 1 r per month. In this case 550 months would be necessary to produce an erythema, this about representing the average working life of an individual. One must, however, take into consideration also the amount of ionization of the air produced in the roentgen room. For this reason the author proposes that the tolerance dose be expressed separately (1) for the roentgen rays, the "roentgen tolerance dose" and (2) for the ionization of the air, the "ionization tolerance dose." Whereas the importance of the first is now generally recognized it remains for future investigations to determine the deleterious effect in connection with the latter (ionization of the air and ozone effect).—*T. Leucutia.*

SCHECHTMANN, J. Die Luftionisation in Röntgenräumen. (The ionization of the air in roentgen rooms.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1930, *42*, 639–644.

During the course of experiments for the determination of the ionization of the air in roentgen rooms, it was observed that the ionization is always unipolar, that is, of a positive character. A review of the literature revealed that Sokoloff has been the only one to observe this phenomenon, although he failed to give a satisfactory explanation for it. The author, in measuring the ionization of the air by means of Ebert's aspiration device (see above abstract) found that the ionization as a rule reaches high values, occasionally as high as several hundred thousand ions per c.c. of air. After the roentgen apparatus is shut off, the ionization returns to normal within a few seconds.

The ionization of the air in roentgen rooms is caused partly by the roentgen rays and partly by the electrical diffusion of the high tension conductors. In both instances it is bipolar. The apparent unipolarity is simply the result of the position of the high tension conductors in relation to the measuring device. Thus, when the high tension conductors are symmetrically arranged, nearly all of the negative ions are attracted to the positive pole, the positive ions remaining in the air. Through a corresponding change in the arrangement of the high tension conductors, one may obtain a prevalence of either of the ions in the air of the roentgen rooms.—*T. Leucutia.*

HABS, HUBERT. Die Gefahr des Palpierens mit der ungeschützten Hand. (The danger of palpation with the unprotected hand.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1930, *42*, 779–781.

The author investigated by means of physical measurements the danger of the roentgen rays (the qualities analyzed including 140, 100 and 80 kv. max. and from 0.5 to 6 mm. Al filters) on the unprotected hands during fluoroscopic examinations. It was found that the dose often exceeds the tolerance dose of 5 r per month considered as safe by Glocker, Mutscheller, Barclay, Cox, and others. The thickness of the patient is from this standpoint very important whereas the quality of the roentgen rays seems to be of no significance. Since the opaque glove of Berg gives sufficient protection, it is recommended that this be used whenever palpating during fluoroscopy.—*T. Leucutia.*

Remy, Charles E. Moral and physical aspects of the x-ray film storage problem. *Modern Hospital*, 1930, *34*, 59.

The author, a former hospital superintendent, presents his views on the film storage question. He divides the film storage problem into three phases as presented to the hospital executive: (1) the moral aspect—the reasons for storing films and the reason for their retention after their first purpose of aid to diagnosis has been served; (2) the physical problem of their storage, and (3) the matter of the fire hazard attendant on the storage of these films.

He divides the moral aspects of the question as follows: (1) the medicolegal responsibility of the hospital or clinic; (2) the professional responsibility for maintaining a file of all records intact, and (3) the scientific responsibility, that is, the responsibility of accumulating a scientific film library, a museum of roentgen data.

In regard to the medicolegal aspect of the problem, it is a matter of individual state law as far as the calendar period is concerned, but the moral aspect is the same in all states, namely a compliance with regulations the state has seen fit to establish to protect the rights of its citizens. For the period thus fixed, all institutions and medical practitioners shall be responsible for the retention of roentgen films for the protection and support of citizens in the event of legal controversies. The author feels that the hospital superintendent need have no qualms of conscience about the moral responsibility to the hospital's clients for retaining films longer than the legally specified time in any particular state. It has been his observation in both out-patient and in-patient departments after the lapse of even a year, that the physician, in studying the patient's past history in relation to his present complaints, depends almost exclusively upon the report of the roentgenologist rather than upon the film and its interpretation. He believes the physician deludes himself into thinking that because of the interest in his patients and in the clinic's patients he will refer to the original film if he is called to care for that patient three or six years later. He adds, however, that the hospital superintendent should not allow himself to be similarly deluded as such fantasies will cost his hospital money that might well have been used for new equipment, added supplies or greatly needed additional personnel. Keeping the file of roentgen films unbroken and intact has become a sort of fetish with many hospital superintendents. He says the idea of such unbroken continuity was conceived and nutured in the bosom of the attending medical staff. The average roentgenologist looks askance at it and questions its legitimacy, but it has been adopted as a policy by hospital boards on the recommendation of the medical staffs. Any roentgenologist will state that in his frank opinion, 95 per cent of the films developed in any roentgen laboratory are but repetitions of thousands of other films that have been made of the same portions of the human body. No average physician would undertake the expense of buying bookcases for filing a hundred or thousand medical journals containing the same and only one article of interest, so why ask medical hospital boards to do something quite analogous.

It is far better in the author's opinion to foresee the staff members' inertia in this matter and supply them, a readily accessible, thoroughly indexed bulk of films, each of which has a valuable message to transmit. Space is too costly for routine complete filing of all films, besides such filing is entirely too unwieldy and prevents ready, accessible study and accumulates a vast storage of roentgen films which must be all reviewed for the sake of a comparatively small number of essential films. A scientific roentgen library may conform to one of three types: (1) all films depicting unusual, rare or particularly interesting anatomic, pathologic or medical facts, stored or cross-indexed in such a manner that they may be readily accessible for study, all other films being retained for only the legal length of time and then destroyed, thus conserving space; (2) lantern slides may be used for all important films, such reductions requiring very little space for storage, and (3) a library may be collected combining both these methods

From a physical standpoint there are three types of film storage: current file film storage, dark room film storage, and permanent file film storage. There are three types of films in the current file, which differ only in the length of time it is necessary that they be retained in the file. The films of the orthopedic cases must remain in these cabinets the longest time. The author estimates for these a six month interval. Films of gastrointestinal cases should remain six weeks and those of general medical and surgical interest would only have to be re-

tained about two or three weeks. At the end of the specified time these films may be removed to the permanent file or sorted and the unessential ones destroyed, according to the policy of the particular institution. The usual three-drawer, all-metal, filing cabinet which has a capacity of about four hundred envelopes per drawer should be sufficient for a hospital of 500 beds for storage of the current file. They may be placed in the steel cabinet in the office of the roentgen department or in a storage room just off the "viewing room," preferably a vault, provided with an outside, very ample, vent and an automatic sprinkler, and equipped with vapor-proof electric bulbs. The outside wall should have an area of flimsy or easily crashable wall so that in case of explosion the release will occur readily into the open air and outward. A closely fitting heavy, steel regular vault door should be supplied.

The dark room contains films in three states: (1) a certain amount of new, unexposed film. If in quantity there is of course the danger of fire hazard in the case of nitrate films; (2) the films undergoing the developing and fixing process, which also includes the drying process. Such films require no especial handling, except that the entire new film supply of the hospital should not be kept in the dark room. It should, however, have a sprinkler system, vapor-proof electric bulbs, and all electric switches placed outside the room itself; (3) the permanent film file. Only two types of storage space are feasible if the nitrate film is continued in use and the same types of storage are necessary if acetate films are stored in large quantities, either a storehouse upon the roof, or a separate building. The choice of these depends upon the convenience of the institution. A ventilating system entirely separate from any other hospital ventilating system is necessary. A large crashable or flimsy wall area is also demanded. Likewise an automatic sprinkler system and the other safety devices previously mentioned for the current file storage. Entrance must be directly from outdoors.

The title of safety films for the acetate base films is misleading. They are slow burning but the author states that a representative of a prominent fire underwriters association stated that he did not know whether or not these films would give off poisonous gases. They do not produce as clear or as distinct an image as the usual commercial films. Remy states that they are more fragile and that they curl and break badly. In addition he makes the statement that it is difficult for him to comprehend just how a type of film that is objectionable to manufacturers of moving picture films can be seriously considered for delicate diagnostic work, the possible determination of life or death for human beings. There also remains the final objection for hospitals, that of greater expense. As he sees the problem, it is not the degree of inherent or latent danger in any article that determines the hospital's acceptance or rejection of it as a valuable commodity for daily use; it is the question of preparedness on the hospital's part to nullify those dangers by intelligent protective devices.—*R. S. Bromer.*

Spillman, Ramsey. Why x-ray films should be preserved indefinitely. *Modern Hospital*, 1930, *35*, 63–68.

Spillman believes that the article by Remy (see above abstract) contains statements that are fruitful seeds for discussion between hospital superintendents and roentgenologists. He, as a roentgenologist, differs with Dr. Remy who quotes the opinions of the "average roentgenologist." As a roentgenologist he desires to state his opinions which differ from those of Dr. Remy.

First is the statement that few physicians will make use of films exposed in previous examinations of patients only on very rare occasions, and that they rely on the report of the roentgenologist rather than upon the film and its interpretation. Spillman feels that to throw out old films and to rely on the report alone is to abandon a priceless wealth of material—to cite one instance—on the early development of tuberculosis. Great life insurance companies retain film after film of the cases of early tuberculosis that come under their observation. This material accumulates by the simple process of saving all films, filed so as to be accessible, and in the cases in which frank tuberculosis develops, the process is traced back in the earlier films to a stage where it is recognizable. Thus one of the greatest financial institutions in the world is doing just what Remy recommends should not be done, because it pays dividends in increased knowledge and in a reduced illness rate among its employees. While this may be objected to as a special case and deals with a life insurance company, a hospital is under the same obligation to render the maximum of service. Also old roentgen films of the urinary tract are of enormous value for comparison.

Spillman has been helped immeasurably in his private practice in the study of gastrointestinal cases by access to films of a gastrointestinal series made elsewhere four years before. To trace rachitic changes from infantile to adult life requires the storage of old films.

Even if a roentgenologist were able to describe every minute spot of light or dark on a roentgen film, the expense of providing stenographers to write out his microscopic descriptions would far exceed the cost of the storage of films. He believes that the problem of storage of films has been greatly exaggerated and the question of whether or not the roentgen films should be preserved is a matter that should be under the authority of the roentgenologist.

Spillman believes that proper indexing, cross-indexing, etc., refutes Remy's statement that 90 per cent of useless films must be reviewed in order "to glean the kernels of knowledge hidden somewhere in the mass." He also thinks that acetate films are not as objectionable as stated by Remy. He reviews the history of the gradual development of acetate films, the attempt to secure a safer film, and believes that now this film is entirely satisfactory, answering individually each objection raised by Remy. He quotes the War Office Report, the Proceedings of a Board of the Chemical Warfare Service, and agrees with Remy on the dangers of nitrate base films. He quotes the report of the Underwriters' Laboratories which makes the statement that the cellulose acetate base film is in a class with ordinary paper in similar form and quantity with respect to the hazard to life and health of its smoke and fume in a fire. This answers Remy's quotation that the representative of a prominent fire underwriters' did not know whether or not the acetate film would give off poisonous fumes in case of serious fire.

In the hospital with which Spillman is connected over 11,000 films were exposed last year, 1929. The file of acetate films since 1925, occupies scarcely half the shelf space in a room, 12 feet long, 5 feet deep, and 11 feet high. This room is illuminated with a sessile electric light fixture and no steam pipes are in the room. Smoking is not permitted and the danger of fire is remote. Thus he cannot agree with Remy that this represents an unreasonable expense for film storage. He disclaims any fetish of an unbroken file of roentgen films. He does not care what becomes of the films as long as they are available for future reference. In private practice he sends most of the films of the patients he examines to the referring physician and it is the latter's problem to preserve them. His conscience, he states, is clear as he has never sent to any physician a nitrate base film. As for the suggestion that all electric light switches for the developing dark room be placed outside the room, Spillman asks whether or not it is impossible for someone to come along and innocently, ignorantly, idly or even maliciously turn on the white light from the outside and so ruin the roentgenologist's or his technician's work. Vapor-proof electric light bulbs and switches outside dark rooms are recommended by Remy because nitrate base films are said to give off gas constantly. Spillman does not believe that Remy has consulted sufficient authorities to prove this statement. In regard to the cost Spillman thinks that the difference of 20 per cent is a small price to pay for the relative safety of the acetate films.

He summarizes his article as follows:

1. Reasons exist, adequate to roentgenologists if not to hospital superintendents, for the preservation of all acetate base films indefinitely.

2. The accumulation of a large quantity of films does not work against their being useful for research purposes if there is a proper cross-index system.

3. The cubic space needed for the indefinite storage of acetate films is a trivial fraction of 1 per cent of the cubic contents of the hospital.

4. The underwriters do not require vented vaults for the storage of acetate films.

5. Laws of the State of New York forbid the use of nitrate films, and an extension of such laws may reasonably be expected in the near future.—*R. S. Bromer.*

Jaubert de Beaujeu, A. La radiographie instancée du coeur à 3 m. 50 de distance. (Instantaneous roentgenography of the heart at 3 meter 50 cm. distance.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 334–336.

In 1926 the author presented his first roentgenograms of the heart obtained with 180 to 200 kv. at a distance of 2 meters 25 cm. Since then by further perfection of technique the distance has been increased to 3 m. 50 cm.

The advantage of such a great distance is that the heart appears with very little distortion. The method, however, does not permit a very accurate localization of the G point. In

order to overcome this difficulty, the author undertakes a preliminary orthodiagraphic study of the heart, estimating the G point by its relation to points D and D′ which can be exactly localized. Point G′ is determined according to the method of Vaquez and Bordet.

More recently the author also made a study of the lungs by means of teleroentgenograms. In the near future he will publish the results of this investigation.—*T. Leucutia.*

CONTE, ETTORE. Ulteriori ricerche intorno all' azione biologica di radiazioni a varia lunghezza d'onda. (Recent research on the biological action of radiations of different wave length.) *Radiol. med.*, June, 1930, *17*, 689–698.

The author continued his experiments on the antagonism between the action of ultraviolet and infra-red rays and tried to determine whether there was such an antagonism in the action of these two kinds of rays in experimental rickets of white rats. He found that there was no such antagonism in this respect.—*Audrey G. Morgan.*

CAPPELLI, LUIGI. Ricerche immunologiche biochemiche sull'attività biologica delle radiazioni X e gamma. (Immunobiological and chemical study of the biological action of roentgen and gamma radiation.) *Radiol. med.*, Aug., 1930, *17*, 905–915.

It seemed reasonable to the author to suppose that roentgen sickness is caused by damage to the body proteins by the rays, which makes them act on the organism like a foreign protein. The clinical picture of roentgen sickness is very much like that caused by the parenteral introduction of foreign protein. If there is any denatured protein circulating in the body in roentgen sickness it should act as an antigen and produce antibodies. Precipitation should be brought about if a blood containing such antibodies is brought into contact with one containing the antigen.

He tested this theory by experiments on rabbits. A series of rabbits were irradiated with a considerable dosage of roentgen rays, giving as much as ¼ of a skin unit at a dose with intervals of a week between the individual doses; a total of 2 skin units, or 1300 R, was given in the course of two months. Other rabbits were then irradiated and the supposedly antigenic blood removed at about the time roentgen sickness occurs, that is, 10–12 hours after irradiation. There was no flocculation to indicate that any change had been brought about in the protein. Apparently therefore irradiation does not change body proteins, at least not to such an extent as to produce a condition of immunity with the formation of antibodies.—*Audrey G. Morgan.*

CAPPELLI, LUIGI. La "radioanafilassi" nell'organismo normale. (Roentgen anaphylaxis in the normal organism.) *Radiol. med.*, Sept., 1930, *17*, 1084–1090.

In a previous series of experiments the author showed that roentgen rays do not bring about a roentgenproteinemia that causes immunity. But that does not prove that the rays do not change the proteins. Foreign proteins cause two distinct and contrary kinds of change in the body proteins: immunity which is prophylactic and desensitizing toward the antigen and anaphylaxis which is hypersensitizing. Using the same protein small doses cause immunity and large doses anaphylaxis. It seemed possible therefore that the radioproteins exceed the amount necessary to produce immunity and reach an anaphylactic dose.

Further experiments were made on rabbits to test whether this is true. Parallel series of experiments were made with serum anaphylaxis and radio-anaphylaxis. But they showed that irradiation does not cause anaphylactic shock in rabbits nor does it split the physiological proteins of the organism into albumoses and peptones.—*Audrey G. Morgan.*

BAUMANN, R. Experimentelle Thalliumeffekte an Ratten und Mausen. (Experimental effects of thallium on rats and mice.) *Acta radiol.*, Sept. 30, 1930, *11*, 425–443.

Dustin and Wätjen showed that arsenic has a caryoclastic action and the author's experiments show that thallium has also. The caryoclastic action of metals is not specific for any one special element. The caryoclastic action is the same as the effect of radiation. Tissues that are highly sensitive to short wave-length radiation are also sensitive to caryoclastic poisons. This is true of the hair follicles, thymus, testicles, spleen, lymphatic glands and perhaps also other organs not yet examined. The degree of sensitiveness of the organs and tissues to roentgen rays is largely the same as their sensitiveness to caryoclastic poisons. Indirectly these facts furnish fresh proof that sensitiveness to roentgen rays is a kind of general sensitiveness, or in other words, that roentgen and

radium rays, and consequently other caryoclastic poisons are nonspecific in their action. Theoretically it should be possible to obtain the same palliative effects on tumors with caryoclastic poisons as with radiation but in practice this is made impossible by the fact that they cannot be applied locally. The animals die from general intoxication.—*Audrey G. Morgan.*

Krebs, Carl, Rask-Nielsen, Hans Christian and Wagner, Aage. Radio-sensibility of the lymphosarcomas. *Acta radiol.*, Nov. 15, 1930, *11*, 487–499.

On irradiating lymphosarcoma tissue from white mice in vitro it was found that such tissue when implanted did not take when the dose of rays given was 2 erythema doses and that the percentage of takes was considerably reduced when 1 or 1.5 erythema dose had been used.

On irradiating lymphosarcomas from the size of a pea to that of a walnut in live animals it was found that 1 and 2 erythema doses often had a considerable inhibitory effect on the growth of such tumors and that, in many cases, the tumors disappeared completely. From the fact that 2 erythema doses do not always produce such complete disappearance, the authors conclude that the effect of the irradiation on the tumor tissue in vitro is not absolutely lethal, but only sufficiently inhibitory to prevent it when implanted from overcoming the natural resistance of the organism.—*Audrey G. Morgan.*

Hummel, Rudolf. Über Beziehungen zwischen Cholesterinstoffwechsel und Röntgenkater. (The relation between cholesterin metabolism and roentgen sickness.) *Strahlentherapie*, Oct. 18, 1930, *38*, 308–314.

In man there is generally a decrease of cholesterin in the serum after roentgen irradiation. But in some cases there is an increase of cholesterin. It was impossible to demonstrate a parallelism between the decrease of cholesterin in the serum and roentgen sickness. A decrease of cholesterin in the whole blood seems to coincide with roentgen sickness. Burgheim recommended giving cholesterin on days of irradiation in order to raise the lowered cholesterin content. He had a cholesterin-lecithin preparation made which he called colsil. He found that it had a good effect in over 100 cases of roentgen sickness. The author tested colsil treatment in roentgen intoxication and only saw marked improvement in a fourth of the cases.—*Audrey G. Morgan.*

Casati, Annibale. Experimentelle Untersuchungen über die Röntgenwirkung auf das Knochenmark. (Experimental study of the action of roentgen rays on the bone marrow.) *Strahlentherapie*, Oct. 18, 1930, *38*, 315–321.

In the normal bone marrow of young rabbits that have been irradiated with 1600 r, or 2 h, there is an active process of regeneration fifty days after the first irradiation. Among the normal bone marrow cells ones with round nuclei predominate, either with or without granulations; there are only a few cells with segmented nuclei. There were a few transition forms. There were also many cells which made up a part of the reticulum that contained granules similar to those of myelocytes and which might be interpreted as transition forms. They showed a tendency to develop toward the more differentiated normal forms. Photomicrographs of the findings are given.—*Audrey G. Morgan.*

Rewbridge, Allan G., Hanke, Milton T., and Halpert, Béla. Further observations on the function of the gall bladder. Experiments with methylene blue on the dog. *Am. J. Physiol.*, Dec. 1, 1930, *95*, 511–518.

Halpert and Genke found that after oral administration of methylene blue in rabbits the dye ceased to be excreted by the liver in thirty hours and remained in the gall-bladder forty-two hours longer. They concluded that under ordinary conditions the bile does not leave by the cystic duct in rabbits. In their study, the authors used the dog instead of the rabbit and they conducted four series of experiments: (*a*) the acute experiments, in which they injected methylene blue intravenously and collected bile from the ductus choledochus at various intervals to find when the dye first appeared in the bile; (*b*) the feeding experiments, in which the dogs were fed the same quantity of dye by stomach tube and then two groups were operated at twenty-four and forty-eight hours, at which time the collection of bile was the same as in the first experiment; (*c*) the injection experiment, in which the methylene blue was given intravenously, and then the dogs were operated on for collection of bile between the 36th and 60th hours; (*d*) the second injection experiment, in which eighteen hours later a sample of bile was taken and the hepatic duct was ligated just below the cystic duct in 6 dogs,

and the common duct was ligated in 3 dogs, and then five days later the dogs were again operated on and sample of bile was taken.

From this series of experiments the authors found, first, in the acute experiments, that after injection the dye first appeared in the bile of the ductus choledochus in three to thirty-two minutes, and the highest concentration was reached in two hours. At the same time, the bile removed from the gall-bladder contained one to two times as much dye as that found in the ductus choledochus. They also noted that methylene blue appeared in the saliva at about the same time it appeared in the bile, and was invariably in the gastric juice and duodenal contents at the close of the experiment.

In the feeding experiment, it was noted that bile disappears from the bile of the liver in thirty hours, and from the gall-bladder between the 30th and 48th hour. This indicated that there was inadequate absorption of methylene blue from the gastrointestinal tract, and to reduce this variable they carried out the rest of the experiments after intravenous injection.

In the injection experiment, it was concluded that the dye disappears from the bile of the liver at about thirty-six hours and from the gall-bladder from thirty-six to sixty hours. In other words, they decided that there was a more or less complete change of contents of the gall-bladder in twenty-four hours.

In the second injection experiment, the concentration of dye present was about the same whether some of the bile was reaching the duodenum or whether there was complete obstruction. It was shown that under these conditions the bile was not absorbed rapidly enough from the gall-bladder to account for a more or less complete exchange of contents in twenty-four hours, and it was necessary for the authors to assume that a great deal of the dye left by the way of the cystic duct.

There was a great individual variation noted in the excretory powers of the liver and the resorptive performances of the gall-bladder in all the experiments. The dogs continued on their usual diet at regular intervals in these experiments, and in this connection it was noted that unsatisfactory feeding retards the exchange of bile in the gall-bladder.

This article contains tables in which the detailed data are recorded for each experiment. —*V. C. Johnson.*

GLASSER, OTTO, and PORTMANN, U. V. Erythema and tolerance doses in American clinics. *Radiology*, April, 1930, *14*, 346–350.

A study of the answers obtained in 65 questionnaires sent to American therapy institutions in an attempt to obtain information on the correlation of the data relative to the erythema dose on the human skin as measured in r-units, permits the authors to draw the following valuable conclusions:

1. Such terms as "erythema dose," "skin unit dose," "tolerance dose," etc., can and should be replaced by the much more accurate indication of dose in r-units and in effective wave lengths, together with a statement of the radiation conditions involved. A careful study of each individual patient and of the various other factors that also influence the total effective dose should always be made.

2. An average erythema dose, according to the present use in deep therapy, for specified radiation conditions, corresponds to about 930 r if measured on the patient, and about 660 r if measured in the air.

3. The question as to the number of r-units equivalent to other clinical doses, such as the minimum erythema dose or tolerance dose, and also the question as to the influence of quality upon the number of r-units per erythema, still remain unanswered.—*J. D. Camp.*

HAEGER, ERNST. Verkürzung der Belichtungszeit und Verbesserung der Bildwiedergabe von Röntgenaufnahmen durch Anwendung eines besondern Fortbelichtungsverfahrens. (Shortening of the exposure time and improvement of the processing of roentgen films by the use of special after-exposure procedure.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Aug., 1930, *42*, 233–252.

Becquerel in 1841 discovered that the photochemical decomposition of the halogen salts once started by the blue-violet rays continued following after-exposure to the yellow or green light, leading to intensification of the photographic image. On the other hand, the after-exposure to red light destroyed the primary light effect, leading to a fogging of the image.

By making use of this principle, the author worked out a procedure for the after-exposure of roentgen films and has constructed a lamp combining various color filters (for which a patent was applied for). The roentgen film, which is taken in the usual manner except that

it must be somewhat underexposed, is treated for two minutes in a narcotic bath (pinacrytol green 1:5000), then exposed in the dark room for additional three minutes to the light of the special lamp and finally developed in the routine way.

The procedure, in addition to the fact that it leads to a marked shortening in the primary exposure time (30 to 50 per cent), leads to a very sharp definition, especially of the denser shadows as, for example, calcified interlobar pleural thickening (a roentgenogram of which is reproduced), etc.

The author also discusses in detail the various methods of development and arrives at the conclusion that the tank method with the use of methol hydroquinone developer does not gives as satisfactory results as the dish method with brenzkatechin caustic soda solution. The best results were obtained with the kodak films coated with ammoniacal emulsion.

The opinion is expressed that the method will be of considerable practical value.—*T. Leucutia.*

Reiter, Michael. Über das Problem der seitlichen Beckenaufnahmen und der Beckenmessungen. (The problem of lateral pelvic roentgenography and pelvic measurements.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1930, *42*, 372–375.

A good lateral pelvic roentgenogram can be obtained in a pregnant woman with 20 ma., 88 kv. effective, 15 to 20 sec. exposure, 1 mm. Al and 5 mm. wood filters.

For the measurement of the pelvic diameters, the author uses Guthmann's method which he has modified so that it may be used with any table.

The author expresses the opinion that a good estimation of the pelvic diameters can be obtained from the roentgenograms, but that one has to be very careful in the interpretation of the diameters of the fetal skull.—*T. Leucutia.*

Parkhurst, Howard J. The effects of light on the skin. *Radiology*, Sept., 1930, *15*, 395–400.

The rays of direct sunlight range from the infra-red, or heat rays, of long wave length, through the red, green, and violet of the visible spectrum to the chemically active ultraviolet rays, of shorter and shorter wave length, seldom less than 290 millimicrons (2,900 Angström units), even on mountain tops. Artificially, the ultraviolet wave lengths can be brought down to 10 millimicrons, but the author considers 220 millimicrons as the lowest wave length of importance, and the rays of about 300 millimicrons (3,000 Å) as biologically the most active. There are more ultraviolet rays at high altitudes and less at lower levels. The strength of the sunlight also varies with atmospheric conditions, the time of the day, and the presence of reflecting media such as snow, ice, and water. It seems that the ultraviolet rays are chiefly responsible for damage to the skin, although in some isolated cases certain other spectral groups have a specific irritating action.

Sunburn is cited as an acute effect of light on the normal skin. A chronic effect of light on the normal skin is more or less tanning usually following a sunburn, especially if the skin is repeatedly exposed to sunlight. As the skin becomes tanned and the exposure to sunlight is greatly prolonged, the horny layer becomes thickened and brownish, owing to changes in the other epidermal cells. Long exposure may be followed by the appearance of a chronic erythema, dryness, roughness, and telangiectasia. The accompanying vascular changes may predispose the affected areas to various dermatoses.

The action of light on pathologically light-sensitive skin is discussed. Hydroa aestivale is a rare skin disease characterized by the appearance of large or small vesicles, often followed by varioliform scars, on the exposed parts, appearing chiefly in the warm seasons. In severe cases scarring may cause marked disfigurement, such as the loss of the tip of the nose or the finger tips. The eruption is usually produced by ultraviolet, but sometimes by visible, rays. The eruption of hydroa aestivale is readily differentiated from erythema multiforme bullosum, dermatitis herpetiformis, the rare epidermolysis bullosa hereditaria, and vesicular eczema. Aside from the exclusion of light, no effective treatment has been devised.

The chronic polymorphous eruption due to light is a papular and eczematoid eruption on the face and the dorsa of the hands, and some observers consider it to be a mild form of hydroa aestivale. It occurs much more frequently than hydroa aestivale.

Pellagra is an affection of the digestive tract, central nervous system, and skin, which appears after exposure to direct sunlight with erythema, some edema, and occasionally vesicles, followed by scaling, hyperkeratosis, pigmentation, and sometimes slight cutaneous

atrophy. Accompanying eruptions often appear on the elbows, arms, axillae, genitalia, and perineum, and at the same time certain parts which are exposed to the light may not present the eruption. The tongue usually presents a beefy, denuded appearance which is of diagnostic importance. The chief symptoms are dermatitis, diarrhea and dementia. A poorly balanced diet seems to be an important etiologic factor, and when this is corrected improvement usually ensues. Pellagroid eruptions resembling pellagra are often seen in alcoholic or cachectic individuals, and a defective diet is an important factor here also.

Cases are mentioned in which a pruritic, infiltrated, vesicular dermatitis appears on the exposed parts at each menstrual period. The ultraviolet rays seemed to be responsible. The outbreaks faded after roentgen treatment of the ovaries. External applications, especially tar, may sensitize the skin to light, at least temporarily, and tar products, especially when employed in outdoor work, seem to constitute an industrial hazard. Eosin and other fluorescent substances, given internally, have produced light sensitization. Acridine derivatives, such as trypaflavin and gonacrin, used in the treatment of gonorrhea, have been found to produce light sensitization. Resorcin was administered to counteract this condition. The administration of luminal has been known to produce an eruption resembling hydroa aestivale, with porphyrinuria. Trional has sometimes produced a pellagroid eruption.

Xeroderma pigmentosum is a rare condition in which the exposed parts of the skin become senile during the patient's childhood. Most of these patients die before the age of twenty, but there are instances of coal miners and other workers who strictly avoided sunlight and thereby managed to survive. Sailor's skin is a similar condition occurring after middle life especially in those who have been much exposed to direct sunlight, and particularly in those who have been exposed to tar. Years of exposure to the light may also be followed by degeneration of the elastic and collagenous tissues of the exposed skin. There is a possibility that prolonged exposure to ultraviolet rays of artificial origin may ultimately produce similar changes in the skin, and this calls for discretion in the use of therapeutic lamps.

Skin diseases aggravated by light or brought out by light include actinic cheilitis, commonly seen in the Rocky Mountain region following several days' exposure to the intense sunlight, herpes simplex, erythema multiforme, in which it is considered that light may be the precipitating factor, and lupus erythematosus.

Psoriasis is often benefited by ultraviolet exposures, but light, as an irritant, may actually aggravate some cases. There have been recorded a few cases of urticaria due to light sensitization. Vitiligo is apparently made worse after exposure to sunlight, but this aggravation is more apparent than real. Hair growth often seems to be favored and accelerated by exposure to ultraviolet rays. This seems especially true of lanugo hair growth. But prolonged over-exposure to intense sunlight may be followed by bleaching, dryness and thinning of the hair.

In addition to the pigmentation and epidermal cell immunity provided by nature, further protection is offered by clothing and window-glass, ointments, creams, liniments, lotions and powders. Four per cent esculin-glycerin ointment is said to be valuable. Resorcin has been employed internally and in ointments, but it has been administered by mouth and at the same time used locally in a 2 per cent ointment, in cases of Hutchinson's prurigo, with no apparent benefit.—*J. D. Camp.*

Dobrovolskaia-Zavadskaia, N., and Kobozieff, N. Filaire et cancer chez la souris. (Filaria and cancer in the mouse.) *Arch. Inst. du Radium de l'Univ. de Paris*, 1930, *2*, 273–289.

Summary. The filaria which we have found in some mice in our breeding corresponds to the variety described by Borrel and called by Sambon, *Muspicea borelli*. It appears to play no specific rôle in the origin of cancers in our mice since it is encountered in adenocarcinoma of the breast as well as in other neoplastic conditions. In all the cases in which the filaria has been observed in the mammary area, the animals were carriers of cutaneous parasites, indicating the probability of an intermediary host. The small percentage of the cancerous mice with filaria seems to prove that the great majority of cancers in our breeding (87 per cent) developed independently of the presence of the parasite.

The small epithelial nodules which are often found in the mammary glands of the mouse have characteristics similar to those of the adenocarcinomas of the mamma; they can develop

without the participation of the filaria. On the other hand, the presence of the filaria in the mammary gland does not necessarily cause the appearance of the nodule.

The method of Borrel is an excellent procedure not only for the detection of the filaria but also for the study of the mammary glands in various pathologic conditions, especially at the beginning of cancerization.—*T. Leucutia.*

Guében, Georges. La répartition du rayonnement autour des tubes de radium. (The distribution of radiation around radium tubes.) *Acta radiol.*, June 30, 1930, *11*, 237–247.

The author has tried to establish the isodose curves of the radiation around radium tubes by means of a roentgenographic method. The roentgenograms were examined with a recording microphotometer and from the diagrams obtained it was possible to trace the isodose curves. The curves are reproduced. They show some differences from the ones obtained by methods of ionization.—*Audrey G. Morgan.*

Levy, D. M. On border-line rays according to Bucky; their biological and physical properties and therapeutical application. *Acta radiol.*, June 30, 1930, *11*, 204–216.

The author reviews the history of borderline rays, describes their physiology and biology and shows that, with proper technique, there is absolutely no danger in their use.

The borderline rays were first used in skin diseases. In eczema the author gives 1,000 R in three sittings with two weeks interval; in cancroid 8,000 R in five sittings with one week interval; in lupus vulgaris 5,000 R and in pruritus ani and vulvae 9,000 R in three sittings with one week interval. His results have been so good that he now uses borderline rays exclusively in surface treatment. The rays affect the vegetative system particularly. There is no decrease of leucocytes after treating the skin with hard roentgen rays but there is an immediate fall after exposure of 1 sq. cm. of surface to 100 R borderline rays. The author thinks this is caused by a stimulus that starts from the skin, has a centripetal course and goes centrifugally in the spinal nerves to the vegetative nervous system. This decrease of leucocytes alone is a proof that the biological action of the borderline rays is different from that of the roentgen rays. In roentgen treatment 5 per cent of the rays are absorbed by the skin while the rest penetrate deeper; with borderline rays just the reverse is true.

The influence of borderline rays in internal diseases is an indirect one transmitted to the organ through the skin; it is obvious that the rays will be most effective in diseases caused by derangement of the autonomous nervous system. The author has confirmed Bucky's good results in the treatment of ulcer of the stomach and duodenum with borderline rays. The technique used was the same as Bucky's. The object is to exert as great a stimulus as possible on the skin. The body is divided front and back into four sections and each section given 250 R per day. The skin is protected with leaded rubber, only the part which is to be treated being left exposed.

The author treated one leucemia patient with borderline rays but without result; he had good results however in amenorrhea and dysmenorrhea. In these cases, too, the action is general not local and the results are a fresh proof of the interaction between the skin and the glands of internal secretion.—*Audrey G. Morgan.*

Ottonello, Pietro. Il valore del potassio in radiobiologia. (The value of potassium in radiobiology.) *Radiol. med.*, May, 1930, *17*, 580–625.

The author begins by reviewing present theories in regard to cell division and then calls attention to the biological importance of potassium which is a radioactive element, in the karyokinesis of normal and pathological cells. The action of roentgen and radium rays on the cells is generally attributed to the secondary corpuscular rays from the cells themselves. In tumors that grow rapidly there is a larger amount of potassium. Irradiation causes the potassium to disappear from the blood and drives it into the tissues. This relation between potassium, irradiation and tumor is of great biological importance. Roentgen rays constitute a physiological energy for the cells. In addition to acting directly on the cells, the rays have a general action on the organism.

The author reviews the difference in radiosensitiveness between normal and neoplastic cells and recommends giving potassium for the purpose of increasing the radiosensitiveness of the latter; the potassium enters the neoplastic cells, which are particularly receptive to it, and reinforces the effect of the irradiation; the action is comparable to that produced when ra-

dium emanations are given intravenously.—*Audrey G. Morgan.*

Casati, Annibale. Il "Mekapion" nella pratica roentgenterapica. (The mekapion in roentgen therapy.) *Arch. di radiol.*, Mar.–Apr., 1930, *6*, 373–378.

Mekapion is a measuring apparatus which gives the "total" dose expressed in German R units. The author calls attention to some technical points that must be observed in its use in order to avoid differences between the dose administered and the dose registered. The usual distances between the anticathode and the ionization chamber should be used (23 cm., 30 cm., etc.), keeping the distance between the ionization chamber and the skin constant. The ionization chamber should be placed on the line joining the center of the field with the center of the bundle of rays. It must be remembered that the dose registered by mekapion is not that given on the skin but is greater, so the dial should be made to register 10 to 15 per cent more than the desired dose.—*Audrey G. Morgan.*

Herrmann, Heinrich, and Jaeger, Robert. Bleiabsorptionsmessungen an extrem harten Röntgenstrahlen. (Lead absorption measurements with extremely hard roentgen rays.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1930, *42*, 115–120.

Previously (see abstract, this Journal, January, 1931, p. 140) the authors described the principle of a high tension apparatus giving a current of 400 kv. In this article the construction of the apparatus is discussed, a diagram showing the connection being included.

Measurements carried out with a very sensitive dosimeter of the Physikalisch-Technische Reichsanstalt permitted the establishment of lead absorption curves from 200 kv. to 400 kv. It was found that while the absorption coefficients for lower voltages (200 kv.) coincided with the values of other investigators (Kaye, Glocker and Reuss, Berthold, Behnken), those above 200 kv. showed a marked decrease. At 400 kv. the value of the absorption coefficient lay near that measured for the gamma rays of rays of radium. From the practical standpoint this indicates that while a lead thickness of 4 mm. gives sufficient protection at 200 kv., this must be increased to 8 mm. at 300 kv., and 14.5 mm. at 400 kv. It would be advisable to have these data confirmed by biological experiments.—*T. Leucutia.*

Wejdling, Knut, and Bäcklin, Erik. An X-ray spectroscopic study on the transformation of ergosterol in ultraviolet irradiation. *Acta radiol.*, June 30, 1930, *11*, 166–174.

The ergosterol sample used ($[a]_D^{20} = -123°$ $CHCl_3$) showed a lattice constant, that is a distance d between the atomic planes, equal to that of palmitic acid or 35.49Å. So far as the authors know, the lattice-constant of ergosterol has never been determined before. Ultraviolet irradiation with and without accesss of air for periods corresponding to a moderate, strong and weak antirachitic activation (15 minutes, 22.5 minutes and 2 hours) caused a weakening of its capacity to reflect roentgen rays of such a degree that at the moment of the strongest activation not a trace of crystalline structure could be seen on the spectral plates. This condition persisted unchanged throughout prolonged irradiation. No new lattice constant of the irradiated preparation could therefore be determined. This shows that ergosterol undergoes a fundamental transformation in ultraviolet irradiation; this transformation takes place only *during* the ultraviolet irradiation.

The method presented in this study is a new one for studying the activation of ergosterol.—*Audrey G. Morgan.*

Gram, H. C., and Møller, P. Flemming. The results of carbon arc light treatment of intestinal tuberculosis. *Acta radiol.*, June 30, 1930, *11*, 133–165.

Eighteen cases of phthisis in which roentgen examination showed marked signs of intestinal tuberculosis were given prolonged treatment with carbon arc light baths and then re-examined roentgenologically. Five of the patients were completely cured, 3 almost cured, 2 very much improved, 3 somewhat improved, 4 unaffected and one dubious. In 7 of the cases there was slight temporary diarrhea, but this never recurred after the light treatment. The diarrhea was not severe or typical enough in any case to warrant a diagnosis of intestinal tuberculosis without the roentgen examination. In nearly all the cases there was more or less improvement in the general condition, though in many cases the pulmonary process was unaffected or even progressed. Most of the patients took on weight satisfactorily during the period when the light baths were being given.

Overdosage of light may cause a sharp decline in weight, which however does not seem to leave any permanent bad effects. The healing of the intestinal process cannot be due to disappearance of the bacilli in the sputum, for in the majority of the cases there were still bacilli in the sputum after the treatment. The number of light baths given varied from 12 to 75, with an average of 49. The dosage was increased from ten or fifteen minutes to one or two hours at a sitting according to the tolerance of the patient. Cure does not seem to be related to the duration or intensity of the light bath. Cures are sometimes affected after a very short and sometimes after a very long treatment. Even very prolonged light therapy may at times give completely negative results. Re-examinations were made after periods of from 2½ to 10½ months. In several cases in which repeated re-examinations were made the gradual improvement and final disappearance of the pathological process could be followed up. In one case complete cure was seen 2½ months after the first examination.—*Audrey G. Morgan.*

Bouwers, A. Self-protecting tubes and their influence on the development of x-ray technic. *Radiology*, 1929, *13*, 191–202.

Probably one of the most remarkable features in which the European development in roentgen technique differs from the American is the self-protecting tube. The first self-protecting Metalix tube for practical use was demonstrated in connection with a lecture given before the British Institute of Radiology by Dr. Heilbron, in London, in December, 1923. The main body is a chromium iron cylinder, to which glass is sealed directly. Immediately around this cylinder is a lead shield of sufficient thickness, destined to absorb practically all primary radiation from the target. The roentgen beam comes down through the base of the cylinder, which is closed by a glass window. The filament terminals are connected with the plug contacts at the left. Between the circular filament in the center of the cylinder and the anode a metal plate is mounted, having a circular opening. This opening serves as a kind of diaphragm with regard to the electrons attracted by the anode, the lines of force passing through the opening. The right choice of the width of this diaphragm and its distance from the anode and from the cathode enables one to regulate both the size of the focal spot and the voltage necessary to obtain a given milliamperage for a sufficiently heated filament.

The roentgen rays emerge from the target in a direction perpendicular to the surface. In the later type of tube the rays leave the tube through a window in its metal center part at an angle of about 20° with the target surface. The working of the diaphragm is essentially the same in both types of tubes, but in the case of the second type the diaphragm between cathode and anode is a rectangular slit, so that a long and narrow focus, a so-called "line focus," is produced. The new way of "focussing" the electrons by means of the diaphragm makes it possible to build the Metalix tubes in such manner that the distances between the electrodes are much smaller than usual. This feature contributes to the reliability of the tubes. It also proved to be unnecessary to exhaust a Metalix tube to the same extent as a Coolidge tube, and, if suitable gases are chosen (for instance, helium), pressures even much higher than those occurring in gas tubes will do no harm and even seem to improve the life time.

According to the author the line focus has some advantage over a "round focus." In fact, the intensity of radiation is substantially the same in a direction of about 20° with the focal surface as it is in a 45° direction. On the other hand, the projection of the focus, on which depends the definition of the roentgenograms, is smaller in case of the smaller angle. Immediately connected with the question of the focal spot is the input a tube will stand. This input (in watts), though not universally proportional to the time of exposure, will be greater, the shorter the time of exposure, and therefore the input allowed during one second will first be considered. Calculation and experiment have shown that the allowed input should be 200 watts for a focal spot area of 1 sq. mm. For one type of Metalix tube, for instance, the input is 5,000 watts during one second; therefore the focal surface may not be larger than 5000/200 mm. or 25.0 mm. This type of tube has a line focus of 2.7 mm. width and about 8.5 mm. length.

An essential difference between Metalix tubes for deep therapy and those for diagnosis is the metal instead of the glass window. At one point the chromium iron centerpiece is made very thin so that the copper equivalent is about 0.3 mm. Thus it is made impossible to work with a deep therapy Metalix tube with-

out the use of a filter and practically no harm can be done, even should one have forgotten the additional filters for obtaining the desired total thickness.

Quite apart from certain simplifications in roentgen apparatus the Metalix tube has led to some novelties. The first novelty is the Metalix tube with a rotating anode. The nickel cylinder which surrounds the tube contains the field of an electric motor, the armature of which is constituted by the anode itself. Eddy currents in the copper of the anode body are generated by the exterior rotating field, thus forming with it a so-called inductive motor. The latter is a solid copper cylinder which is mounted on special bearings on a molybdenum shaft. At the lower end it is covered by a conical tungsten plate instead of the tungsten "button" used in an ordinary anode. The line focus falls along a descriptive line of this conical surface, so that when the anode is rotated at a sufficient speed the focus, though keeping its place all the time, practically covers the full conical surface of the anode. Very soft roentgenograms were made with this type of tube in about 0.05 second and with 200 to 400 ma. at a distance of 1.5 meter This was not the limit of what the tube could stand, and further experiments will have to be made with special and heavier high voltage apparatus. One may expect that it will soon be possible to make satisfactory heart films in 0.02 second, which will probably open up new possibilities, in the line of roentgen cinematography. The second novelty is the new portable roentgen apparatus, which combines full protection against high voltage with complete safety as regards radiation. The roentgen tube is a Metalix tube with a metal central part connected to earth. This central part has metallic extensions covering the whole tube, so that the latter is completely enveloped by a grounded metal cover. The center of the secondary windings, as well as the cover of the high voltage transformer, is also grounded as are the flexible metal covers of the high voltage cables, connecting tube with transformer. Thus the whole apparatus is completely enclosed in a metal cover, so that it may be touched during operation without the slightest danger. The high voltage is by this arrangement divided up into two equal parts and consequently the insulation problem has been much simplified, for insulation difficulties rise far more quickly than proportional to the tension. A spark gap in air, for instance, between points of 6 cm. is equivalent to about 55 kv., while 16 cm. corresponds to about 110 kv. (peak value). When making use of the principle above, the transformer, the roentgen tube, and the connecting cables can be made of small dimensions and the apparatus can easily be transported in two small cases.

No instruments for measuring voltage and currents are provided in the apparatus in order to obtain the utmost simplicity. The operator, therefore, need not bother about voltage or current. One wants only an exposure table, adjusting the time switch and pressing the button being the only manipulations which are necessary.

The cooling of the anticathode is effected by means of a ventilator, driven by a small motor, fed from the mains. Many roentgenograms can consequently be taken in succession, while screening can be done without any danger of overheating the anode. A particularly high saturation of the iron of the transformer, combined with a resistance of about 4 ohms in series with the primary, has the effect that a variation of the primary voltage has very little influence on the secondary, and, therefore, on the quality of the radiation. A safety device is provided, which prevents the voltage from being switched on before the grounded metal cover of the transformer and the cables have been safely connected, so that there is no possibility of the accessible parts being put under high voltage.

Moreover, a permanent filter of 2 mm. aluminum has been mounted in front of the aperture in order to protect the patient against being hurt by soft radiation. If desired, this filter can be removed by the physician for therapeutic purposes.—*J. D. Camp.*

FAILLA, G. The measurement of x-ray dosage by physical means. *Radiology*, 1929, *13*, 293–305.

Progressive development of radiation therapy requires the proper correlation of cause and effect. In the ultimate analysis this means the establishment of definite relations between the radiation used and the clinical results obtained. To do this it is necessary to have, in the first place, an accurate knowledge of the radiation which is effective in producing the observed results. It is not sufficient to have a knowledge, however complete, of the radiation emitted by the particular source at command.

Since it is not known just how radiation is biologically effective, it is very desirable to have clearly in mind at all times all the factors which may possibly influence the biological changes produced by the radiation. One must think of a dose of radiation as that which is directly responsible for the observed biological change. Since the change takes place in a biological medium, the important thing is the dose at every point of the medium. This cannot be measured by a physical instrument. The dose of radiation at a given point in the medium involves three distinct factors, (*a*) the effective intensity, (*b*) the duration, and (*c*) the quality. Of these only the second is the same at every point and can be measured. The first and the third can be determined only approximately and by indirect means.

The writer is of the opinion that the radiologist should not attempt to estimate experimentally the effective intensity and the quality of the radiation within the irradiated volume. Work of this sort can be carried out best in the experimental laboratory under the proper conditions. He should have, however, a sufficient knowledge of such work to appreciate the assumptions and approximations involved in the data which are made available to him by the research laboratory.

The determination of radiation doses at the point of entry of the useful beam (surface of the skin) is a relatively simple matter; nevertheless, there is a serious difficulty due to the radiation which is scattered by the medium. This radiation on the average is softer than the primary radiation and, therefore, may have a different degree of biological effectiveness. The evaluation of the relative amounts of scattered radiation under different conditions is also a problem to be investigated.

In view of the foregoing considerations, for the present the idea that radiation doses can really be measured within the tissues, or even on the surface, may be dismissed; accordingly the only measurements which should be made in the radiological clinic relate to the characteristics of the radiation to be used. The knowledge derived from such measurements is insufficient for the proper correlation of cause and effect, but it is absolutely essential. In addition, the radiologist should utilize such data as are available to get an estimate of the dose which is effective in producing the observed results.

The principal characteristics of the radiation used in a treatment are: (*a*) the "intensity" and (*b*) the quality. At the present time the consensus of opinion is that intensity measurements can best be made by means of ionization instruments. The use of such an instrument is essential because the spark gap and the milliammeter do not give a definite indication of the intensity factor of the radiation emitted by a roentgen tube.

The quality of the radiation supplied by a roentgen tube is not completely defined by specifying the voltage and the filter. Additional information as to the wave-form and phase relations in the high tension generator is necessary. Owing to uncertainties in spark gap measurements and serious difficulties in the determinations of the wave-form and phase relations, it is more practical to specify quality by stating the following factors: (*a*) the general character of the high tension apparatus, (*b*) the peak voltage, and how determined, (*c*) the filter, and (*d*) the effective wave length (or the absorption coefficient or the half-value layer), stating how it was determined.

The measuring instrument to be used routinely in the radiological clinic should have a large ionization chamber and should be provided with means for periodic calibration. It should be definitely understood that this instrument is intended only for measuring the roentgen output of the machine. When voltage or filter or both are varied in treatment work, the radiologist should make use of the ionization instrument with the idea of obtainng a rough approximation of the treatment time with the new factors. He should then determine the desired duration of the irradiation by empirical means.

An ionization instrument with suitable means for periodic calibration permits the radiologist to duplicate from day to day in his own clinic the essential treatment factors. But he cannot compare his treatments with those given in other clinics unless all instruments are calibrated in terms of the same unit. The definition of an International Unit of X-radiation was adopted recently at the Second International Congress of Radiology. In view of certain technical difficulties in the experimental definition of this unit, no standard instrument was adopted. For the present, therefore, there is no internationally recognized standard of comparison for the calibration of ionization instruments.—*J. D. Camp.*

Kotschneff, Nina, and Arapoff, Anna. Radonwirkung auf die Phosphorverteilung im Intermediargebiet. (The effect of radon upon the distribution of phosphorus in the body of angiostomized dogs.) *Strahlentherapie*, 1930, *36*, 360–367.

Radon solutions (10–30 millicuries) injected by means of a special technique into the femoral vein, into the stomach, the intestine and the gall-bladder of a dog produced decrease of the inorganic blood phosphorus. The radon has a distinct influence upon the distribution of inorganic phosphorus within the body of the animal. The study of the blood of the portal vein, liver vein, kidney vein and femoral veins seems to indicate that a considerable decrease of phosphorus within the kidney vein is responsible for the drop in the inorganic blood phosphorus in other vessels. Further experiments are pending. —*Otto Glasser.*

Zwaardemaker, H., and Feenstra, T. P. Die Wiederbelebung des Herzens mittels weicher Röntgenstrahlen, nachdem es durch die Entfernung seiner permeablen Kaliumsalze zum Stillstand gebracht worden war. (The resuscitation of the heart by means of soft roentgen rays after it had stopped beating on account of the removal of its permeable potassium salts.) *Strahlentherapie*, 1930, *36*, 368–372.

The heart of an eel or frog, the beating of which had been stopped by the removal of its permeable potassium salts, and which was irradiated by means of a Grenz-ray tube (5 mm. distance, 4 ma-hr.) started to beat again after twenty-eight minutes, and continued to beat for six hours. This effect was observed in 14 single experiments. This is the first series of experiments where it could be shown that the electromagnetic roentgen rays had an effect upon the heart similar to the corpuscular, alpha and beta rays, as had been shown previously.—*Otto Glasser.*

Vorschriften für den Strahlenschultz in medizinischen Roentgenanlagen, Bearbeitet von der Normenstelle der Deutschen Roentgengesellschaft. (Rules for radiation protection in medico-roentgen institutes as suggested by the "Norm" committee of the German Roentgen Ray Society.) *Strahlentherapie*, 1930, *36*, 393–400.

This is a report of the safety committee of the German Roentgen Society and contains in thirty-one paragraphs suggestions for protection from high tension, from gases in the treatment and operating rooms, and especially from radiation. The minimum thicknesses of lead which are necessary for protection of the radiologist, the operator, and the patient for various technical conditions are given. The lead thickness suggested for complete protection goes as high as 5 mm. when using 220 kv.—*Otto Glasser.*

Schulze, Walter M. H. Die durchdringende Strahlung in der Atmosphäre. (The penetrating radiation in the atmosphere.) *Strahlentherapie*, 1930, *36*, 270–298.

Since penetrating cosmic radiation might become of considerable clinical importance, the author attempts to collect the results of the experimental work on cosmic rays in order to familiarize medical men with this fundamental phenomenon. The cosmic radiation, which is more penetrating than the gamma rays of radium, is measured by means of very sensitive electrometers. One of these instruments, as developed by Kohlhörster, has a very small capacity (0.3–0.8 cm.), the inside walls are of heavy metals and it has a very sensitive platinized quartz loop filament; it can be filled with heavier gases and permits measuring currents of 10^{-15} to 10^{-18} amperes. In measuring the radiation of the surface of the earth, two components are active, one is the earth radiation, which is due to the radioactive substances in the surface of the earth, and its intensity depends upon these deposits, and also to some extent, on atmospheric conditions. The penetration of this earth radiation varies according to different observers from 0.12 to 0.24 for the coefficient of absorption in lead. The intensity is given by Kohlhörster as being approximately 2.5 ions per cubic centimeter and seconds. Closely connected to the earth radiation is the air radiation, which is produced by the gaseous emanation products escaping from the earth into the air.

The cosmic radiation, first observed on Dec. 11, 1909, by the Swiss physicist, Gockel, has a very high penetration. According to several observers, the coefficient of absorption of these rays in water is approximately 2.31×10^{-3} $cm.^{-1}$. The cosmic radiation is, however, not homogeneous, but it is not possible at the present time to indicate how heterogeneous it actually is. The physical nature of these rays is not exactly known. Bothe and Geiger, on the basis

of exact measurements with the Geiger counter, feel that it is corpuscular in nature, a point of view which is also taken by Skobelzyn, on the basis of observations of beta rays with the Wilson cloud chamber. The influence of the latitude, the electrostatic field of the earth, and various meteorological factors upon the intensity of the cosmic radiation is discussed in detail. A possible biological influence of the radiation is also discussed.—*Otto Glasser.*

Carty, John R. The modification of the biological reaction of living tissue to x-radiation by physical and chemical agents. *Radiology*, Sept., 1930, *15*, 353–358.

A review of the experimental work in the field of artificial x-radiosensitivity has been made. It has been shown that normal tissue sensitivity can be altered by vascular and thermal changes, the application of irritating and toxic substances, ultraviolet radiation, high frequency alternating current, and possibly by the direct electric current.

The author has undertaken experimental work to show the effect of the direct current on tissue sensitivity. At present the work is still quite in the preliminary stage. In controlled experiments with low currents he has been able to produce severe lesions in the skin of the rabbit by applying the negative pole to a heavily irradiated area which had just previously received soft roentgen rays (80 kv) unfiltered. The lesions (deep ulcers, healing slowly, with a heavy scar), are strikingly more severe than the controls and those produced by causing electric burn, using the same factors. With the positive pole he has found that either there may be no noticeable effect, or else that there is occasionally an actual diminution of the intensity of the reaction. A great deal more remains to be done, particularly with heavier currents, before definite conclusions can be reached.—*J. D. Camp.*

Negru, Dimitrie. L'Institut de Radiologie. (The Institute of Radiology.) *Cluj. med.*, Nov., 1930, *11*, 31–32.

The author gives a detailed description of the Institute of Radiology of the University of Cluj which is divided into three sections: (1) roentgen diagnosis; (2) roentgen and radium therapy, and (3) hospital section. A post-graduate course of from three to five years is arranged for physicians wishing to specialize. The teaching of the elementary principles of roentgenology and radium therapy is obligatory in the medical school (two theoretical and two practical hours weekly).

The Institute has made special investigations and published articles on the following subjects: The treatment of infantile paralysis with roentgen rays; the diathermy and electric currents; roentgen diagnosis of articulations, of sacroiliac tuberculosis, of vena azygos lobe, of the demonstration of the spine, roentgen localization of projectiles, etc.—*T. Leucutia.*

Thoraeus, Robert. How far can ordinary milli-ammeters be used for reading short-time currents? *Acta radiol.*, Aug. 15, 1930, *11*, 321–330.

The author reports some measurements carried out to determine to what extent ordinary milliammeters can be used for exact readings of short-time currents. Three different makes of instrument have been tested and observed according to two methods. In Method I the needle is quite free and the maximum deviation is read. In Method II by a specially provided arrangement the needle can be deviated to any position within the scale and then the milliamperage is increased until a slight jerk of the needle appears. Then the current is considered to be practically equal to the pre-adjusted reading.

A disc circuit-breaker specially built for this purpose is described. The test results evidently show that there are considerable errors in short simple readings according to Method I. So Method II should be used for reading short-time currents. With the needle pre-adjusted to a value about 10 per cent below the desired one a small jerk indicates the right milliamperage within about 5 per cent. For practical work this seems to be quite sufficient, especially when compared with the errors in time relays. It is not always necessary therefore to use ballistic instruments.—*Audrey G. Morgan.*

Stenstrom, Wilhelm. Effect of roentgen radiation on certain chemical compounds: (a) tyrosine and cystine; (b) cholesterol; (c) acetylene and propane. *Radiology*, 1929, *13*, 437–440.

Chemical changes are produced when certain chemical compounds in solutions are irradiated with roentgen rays. The average dose per hour of radiation has been determined by the oxi-

dation of ferrosulphate in a weak sulphuric acid solution.

It was found that tyrosine in a weak aqueous or sulphuric acid solution was changed with regard to the phenol group, by roentgen radiation. The quantitative relation has been determined.

Some experiments have been carried out with cholesterol and compared with results obtained by other investigators.

Acetylene and propane in gaseous state have been irradiated for 145 hours. It was found that much larger doses are required to permit definite conclusions.—*J. D. Camp.*

Quimby, Edith H., and Downes, Helen R. A chemical method for the measurement of quantity of radiation. *Radiology*, May, 1930, *14*, 468–481.

The precipitation of mercurous chloride from a mixture of ammonium oxalate and mercuric chloride by the action of roentgen rays has been suggested by Wyckoff and Baker as a convenient means of measuring quantity of radiation. They have presented data obtained by the use of rather low voltage (30 kv.) unfiltered radiation, and a gravimetric method of determining the amount of precipitate. The authors have developed a simple titration method for determining the amount of mercury, and have extended the data to radiation of various qualities from 60 kv. and no filter, to 200 kv. and a filter of 0.5 mm. copper. Within rather wide limits the amount of precipitate formed is proportional to the time of irradiation, other factors remaining constant. Satisfactory results can be obtained with volumes of solution of less than 1 c.c. The method can also be used for radium radiations. Data obtained in this manner differ very little from ionization measurements. A relation has been obtained between quantity of roentgen radiation measured in r-units, and milligrams of mercury precipitated. It is therefore suggested that this chemical method of measuring quantity of radiation may be useful as a secondary standard, particularly in comparing data obtained in different parts of the world. It also offers a quick, simple method for calibrating the output of a roentgen machine in r-units.—*J. D. Camp.*

Brown, C. R. Safeguarding the storage of photographic, motion picture, and x-ray films. *Radiology*, May, 1930, *14*, 454–459.

The storage of nitrocellulose film, whether photographic, motion picture, or roentgen ray, has been shown to be extremely hazardous. Decomposition, which is exothermal, is started at slightly elevated temperatures, and large quantities of highly poisonous and explosive gases are produced. Moreover, the film burns very rapidly and cannot be extinguished readily except by an abundant supply of water. Recommendations for storage have been made which include the use of vented and sprinklered cabinets and vaults of fire-resistive construction, and the avoidance of all sources of heat which might start decomposition or ignite the film. Handling of film should be done by a trained personnel who recognize the hazards involved.

In view of these hazards to both life and property, the characteristics of cellulose acetate film are discussed. This material, called "slow-burning film," is much more difficult to ignite than nitrate film, burns at a much slower rate, and does not tend to give off toxic gases on burning. It is not subject to an exothermal decomposition at moderate temperatures. Its flammability is comparable to that of ordinary paper. While some objections have been made to its use from the photographic standpoint, these appear to have been met in part by improvements in manufacture. Despite its slightly greater initial cost, the reduced cost of safe storage and elimination of the hazards would seem to justify a more general use of cellulose acetate film.—*J. D. Camp.*

Swindells, Frank E. The effect of technic on the speed of intensifying screens. *Radiology*, April, 1930, *14*, 387–390.

A study was made of the effect of changes in the following factors on screen speed: (1) tube potential, (2) tube current, (3) target-film distance, (4) interposition of filtering medium between target and film, and (5) development time.

The following factors were found to have little or no effect on the screen speed: (1) target-film distance (0.5–2.5 meters), (2) tube current (2 to 35 ma.), and (3) over-development.

An increase in the intensification factor was produced by the following factors: (1) increase in tube potential, (2) increase in thickness of absorbing medium, and (3) under-development. —*J. D. Camp.*

Profitlich, P. Die Abhängigkeit des mA-Sek-Produktes von Filter und Spannung. (The dependence of the milliampere-second-product on the filter and tension.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Aug., 1930, *42*, 252–260.

The author calculated the milliampere-second product for various voltages (up to 170 kv.) and various filters (3, 5, 8, 10, 15 and 20 mm. Al). It was found that the time of exposure rapidly decreases with the increase of both voltage and filterage. A mathematical law can be computed only for the light filters in which the decrease of the milliampere second is according to the fourth power.

The author expresses the opinion that the photometric measurement of the dose cannot be replaced by the inometric procedure, at least in the case of very soft roentgen rays. Several tables and graphs are given for the approximate calculation of the milliampere-seconds for various voltage and filterage values.—*T. Leucutia*

Tartagli, Dino. Un semplice dispositivo per il rapido centramento radioscopico-radiografico al troscopio. (Simple arrangement for rapid radioscopic-radiographic centering on the trochoscope.) *Radiol. med.*, Sept., 1930, *17*, 1062–1065.

The author describes and illustrates an arrangement which he has had specially made and applies to the trochoscope for the purpose of being able to change instantly from roentgenoscopy to roentgenography without changing the wires of the respective tubes. He did not see anything similar in the roentgen apparatus at the recent Congress of Turin. It is very simple and enables the roentgenologist to avoid manipulations that are sometimes long and troublesome and not altogether accurate as the centering is accomplished by means of guiding marks on the patient's skin. The author's apparatus and its application are made clear by the illustration.—*Audrey G. Morgan.*

Gunsett, A., and Nourettine, C. Études ionométriques sur la dose additionnelle de diffusion. (Ionometric studies on the additional dose of scattering.) *J. de radiol. et d'électrol.*, Oct., 1930, *14*, 551–558.

The scattered dose is the amount of radiation added to the incident dose on the surface of the skin or of the water phantom, due to scattering of the roentgen rays by the tissues as a result of the Compton effect. Its magnitude is determined by the ratio of the dose measured in air and on the surface of the skin or water phantom.

As is known the scattered dose depends on the following principal factors: (1) size of field; (2) thickness of layer irradiated; (3) penetration of the roentgen rays, and (4) skin target distance. The authors re-checked the laws governing these factors by making use of a Küstner instrument provided with a small graphite ionization chamber and by using pure honey wax instead of water as absorption medium.

The following are the findings: (1) The scattered dose increases proportionally with the size of the field irradiated.

(2) The law governing the dependence of the scattered dose on the thickness of the tissues irradiated is subject to certain restrictions. Rajewsky demonstrated that the scattering resulting from increase in the thickness of the irradiated tissues remains constant after passing a certain limit, which he called the saturation layer. This is independent of the size of the field and of the distance of the focus to the surface of the water phantom but that it depends upon the quality of the radiation. Each quality has its own saturation layer which increases with the penetration of the rays. In the authors' measurements, which included filter values of 3 mm. Al, 0.5 mm. Cu+1 mm. Al, 1 Cu+2 mm. Al and 2 mm. Cu+2 mm. Al, these data were confirmed. For the 2 mm. Cu filter the saturation has not as yet been reached with a 60 cm. layer thickness, the maximum used in the experiments.

(3) The dependence of the scattered dose on the quality of the roentgen rays was analyzed for both the voltage (from 90 to 200 kv.) and the filterage (from no filter to 5 mm. Al and to 5 mm. Cu plus 2 mm. Al). It was found that for the same voltage there was a proportionate increase of the scattering with each filter thickness until a certain maximum was reached, from which on there was a gradual decrease. The same phenomenon was observed for the filterage by changing the voltage. Glocker, Roentgen Kaupp have given the following expl[illegible] the author this rather curious observation: [illegible]an skin in 12 Compton's law the scattering [illegible]ion produced was rays of short wave length [illegible] and Alius erythema factors, one resulting [illegible]o be practically identical of the scattered [illegible]s of radiation. The reason for

electrons and the other from the vibratory rays emitted in every direction with a wave length which depends on the angle of diffusion. With shortening of the wave length the part of energy resulting in recoil electrons increases while that resulting in vibratory rays decreases. If the quality of the roentgen rays is expressed in half-value layer, this apparently paradoxical phenomenon disappears, identical half-value layers giving identical values of scattering regardless of the voltage or filterage. A radiation produced, for example, by 100 kv. and 0.5 mm. Cu plus 1 mm. Al filter will give an amount of scattering which is equal to that of a radiation produced by 190 kv. and 3 mm. Al filter, the half-value layer being in both instances identical (0.44 mm. Cu).

(4) A gradual increase of the skin target distance results in an increase of the scattering reaching its maximum at a distance which varies according to the filters employed. It is, for example, 64 cm. for 3 mm. Al (200 kv.), 80 cm. for 0.5 mm Cu+1 mm. Al and 88 cm. for 1 mm. Cu+2 mm. Al (200 kv.). With 2 mm. Cu+2 mm. Al the maximum was not yet reached at a distance of 1 meter.—*T. Leucutia.*

Dioclès. Les projections en relief. (Projections in relief.) *J. de radiol. et d'électrol.*, Dec., 1930, *14*, 634–639.

The author discusses in detail the various methods for stereoscopic projection of roentgen films and arrives at the conclusion that the procedure of Bellieni is the method of choice if one possesses a sufficient number of stereobinoculars. If the audience is larger than five or six hundred people the procedure by anaglyphs (red and green) with lorgnettes of the complementary color is of greater value. Both methods were extensively used by the author during his recent lectures in the United States and Canada. For the projection of stereoscopic photographs or cinematographic films, the procedure of Almeida is more satisfactory.—*T. Leucutia.*

Clausing, Arthur. Die durch Röntgenapparate erzeugten Störungen des Rundfunk[illegible]empfangs. (The disturbances of radio wave od for can produced by roentgen apparatus.) machine in *a. d. Geb. d. Röntgenstrahlen*, Oct., 7–532.

Brown, C. R. [illegible]eport of the fifth standard-photographic, mot[illegible]the German Roentgen films. *Radiology*, May, 19[illegible]dio reception, disturbances produced by roentgen apparatus, and the prevention.

Briefly, a disturbance in radio reception is produced by any spark contact (motors, generators, switches, automatic tension regulators, rectifiers, high frequency apparatus, high tension transformers, etc.).

The protection consists in the elimination whenever possible of spark formations or in the prevention of transmission of sparks already formed. For the first, one must use close fitting contacts of non-spark producing material with intercalation of spark absorbers; for the second, one may enclose in metal housing all spark producing apparatus, conductors, treatment units, patients, etc., the enclosure being grounded, and may insert high frequency corona absorbers.—*T. Leucutia.*

Chantraine, Enrico. Sulle radiografie dei polmoni col tubo ad anodo rotante. (Roentgenography of the lungs with a tube with a rotating anode.) *Radiol. med.*, Mar., 1931, *18*, 308–314.

Roentgenograms of the lungs made by the usual technique with hard rays do not show sufficient contrast as lung tissue has only a slight capacity for absorbing these rays. To obtain roentgenograms of the lungs with good contrast and rich in detail soft rays must be used and a tube with a very small focus; there must be a long distance between the focus and the film and the time of exposure must be short. These requirements cannot be fulfilled with an ordinary tube with a fixed anticathode but they can be fulfilled with a tube that has now been devised with a rotating anode. To get the best results this tube must be run by a continuous current, such as that furnished by a triphase apparatus with proper filtration. To get roentgenograms of the lungs as clear as those of bone the power of the tube with the rotating anode must be increased to 2000 milliamperes with a tension of 38–40 kilovolts, the diameter of the focus must not be more than 1.5 millimeters the distance between the film and the focus must be at least 1.50 meters, the exposure not more than 1/40 of a second, the reinforcing screen must be very finely granular and the sensitiveness of the films three times as great as it is now.—*Audrey G. Morgan.*

Charpy, P. Dispositif d'orthoradiographie. (Orthoradiographic device.) *Bull. et mém. Soc. de*

radiol. méd. de France, April, 1931, *19*, 170–171.

The principle of a new orthoradiographic procedure is briefly discussed. It consists in taking of serial point roentgenograms of consecutive portions of the heart. The automatically operated tube is displaced horizontally, starting from the upper left end of the cassette, 2 cm. for each consecutive roentgenogram for a number of 10 exposures, then on the next line, 2 cm. below, for an additional 10 exposures, and so on, until 10 lines (for a total of 100 images) are covered, the area extending 20 cm. both vertically and horizontally.

The disadvantages of the method are that the tube must support an excessive load (100 continuous exposures) and that the heart shadow often appears notably distorted. For the improvement of this latter a new device was made synchronizing the exposures with the cardiac rhythm. In a heart with 72 contractions per minute, for example, an exposure is made every 1/72 of a minute (that is every 8/10 of a second), whereas if the rhythm is higher, an exposure is made during every second or third beat (every 1/60 or 1/40 of a minute in case of 120 beats, etc.).

More recently attempts were made to synchronize the exposures also in case of irregular rhythm of the heart by making use of a sphygmomanometric relay. The apparatus will be described in detail later after further improvements.—*T. Leucutia.*

Neeff, Th. C. Wege zu einer exakten Dosierung bei der temporären Röntgenstrahlenamenorrhoe. (Exact dosage methods for the production of temporary roentgen amenorrhea.) *Strahlentherapie*, 1930, *37*, 567–571.

In order to produce a temporary amenorrhea, the exact determination of the roentgen-ray quality and quantity is necessary. A reliable dosimeter, which should be used during the entire treatment, is necessary to arrive at an exact dosage. Furthermore, the dose should be determined directly at or near the organ which is treated.

The author suggests using large areas of treatment, and possibly irradiating the front and back of the patient at the same time by means of a two tube system. If these requirements are fulfilled, it is possible to arrive at an accurate determination of the ovarian dose.—*Otto Glasser.*

Reisner, A. Biologische Versuche über die Wirkung der verschiedenen Strahlenmengen bestimmter Radiumpräparate auf die Haut. (Biological experiments on the effect of various amounts of radiation from certain radium preparations upon the skin.) *Strahlentherapie*, 1930, *38*, 19–26.

The effect of certain radium doses upon the human skin was studied. Dosage data given in the literature (for instance, 560 mg-el-hr. at 1 cm. distance) were found to be about 40 per cent too high. Experiments carried out with a 40 per cent reduction of these doses produced reactions upon the skin which were comparable to the normal roentgen erythema (310–330 mg-hr., 1 cm. distance, 2 cm. length, 1.7 mm. brass and 0.2 mm. platinum filter, total strength 46.2 milligram radium element). It was found during these experiments that the radium erythema shows some difference as compared to the roentgen erythema; the color of the reaction is darker, and the reaction extends over a longer period of time, its maximum effect occurs later, and the pigment is stronger and the deep effect is greater.—*Otto Glasser.*

Braun, R. Vergleich der biologischen Wirkung von Röntgen- und Gammastrahlen. (A comparison of the biological effect of roentgen rays and gamma rays.) *Strahlentherapie*, 1930, *38*, 11–18.

Attempts to correlate the reaction of gamma rays of radium with its strength have not yet led to any definite results. The author, therefore, irradiated anaerobic ascaris eggs with both gamma rays and roentgen rays. He found that 1 mg-el-hr. per cm. from a radium preparation filtered with 1 mm. of platinum and 15 mm. long, produced the same effect as a roentgen dose of 4.06 r.

The experiments then were extended to the human skin, a special radium pack was designed for this purpose which had a uniform distribution of the radioactive substance. The intensity of the pack for a given distance was measured biologically by means of ascaris eggs and found to correspond to 767 r per hour.

With this radium pack and with roentgen rays (1.76 mm. Cu, half-value layer) the author applied 750 and 900 r to the human skin in 12 cases. The course of the reaction produced was measured with a Schall and Alius erythema meter. It was found to be practically identical for the two types of radiation. The reason for

the high number of milligram-element-hours per erythema dose given in the literature is probably due to the time factor involved, and not to the difference in the reaction of the two types of radiation.—*Otto Glasser.*

JÜNGLING, O., and LANGENDORFF, H. Über die Wirkung verschieden hoher Röntgendosen auf den Kernteilungsablauf bei Vicia faba equina. (The effect of various roentgen-ray doses upon mitosis of *Vicia faba equina.*) *Strahlentherapie*, 1930, *38*, 1–10.

After having determined the daily periodic fluctuation in the number of mitoses and the number of nuclei at rest of the root tips of *Vicia faba equina*, the author irradiated the roots with doses of 40 r, 80 r, 175 r, 470 r, and 550 r, with a tube with a silver target ($\lambda = 0.56$Å). It was observed that the smaller roentgen doses (40–80 r) increase mitosis, while larger doses showed a decided retardation and suppression of mitosis. The curves representing these changes of mitoses with time after irradiation are very similar. A decided decrease in the number of mitoses, which starts one hour after irradiation and reaches zero after about fifteen hours, is always followed by an interval which is free from mitosis. This, again, is followed by a repeated increase and decrease of mitosis. The various maxima observed depend upon the size of the dose and also upon the time interval between irradiation and counting of mitoses.—*Otto Glasser.*

SCHMIDT-LABAUME, F., and UHLMANN, E. Über den Einfluss des Luftdrucks auf die Erythem- und Pigmentbildung der Haut. (The influence of air pressure upon the formation of erythema and pigmentation of the skin.) *Strahlentherapie*, 1930, *38*, 54–57.

By means of a combined ultraviolet lamp and a pressure chamber which could be applied directly to the skin, certain doses of ultraviolet light were applied while the pressure was varied from minus 20 cm. mercury up to plus 8 cm. mercury. In the majority of cases thus treated, the irradiation with the positive air pressure produced definite decrease in the formation of erythema and pigment of the skin, while the negative pressure always caused an increase of these reactions. This is explained by the fact that an anemia is produced in the skin by the positive air pressure and a hyperemia by the negative air pressure. The result agrees with the findings of other authors. In some luetic cases variations from these results were found, but a regular relationship between the reactions and this disease has not yet been definitely established.—*Otto Glasser.*

HELD, A. Die Blutzucker-Regulation unter Röntgenstrahlen. (Blood sugar regulation under the influence of roentgen rays.) *Strahlentherapie*, 1930, *38*, 27–39.

Roentgen rays have a general effect upon the blood sugar regulation in the body, as well as a direct action upon the sugar transformation within an irradiated area. The general reaction produces a hyperglycemia, and is due to the formation of certain products produced by the reaction to the rays. This can be proved by producing a hyperglycemia from the injection of irradiated blood from the same body. The direct radiation effect was studied by comparing the venous and arterial blood sugar of an irradiated and non-irradiated area. In the irradiated area a relative hypoglycemia was found, which can be considered as a direct reaction to the rays. Experiments were made on dogs and rabbits.—*Otto Glasser.*

ACTION OF ROENTGEN RAYS AND RADIUM ON THE HEART AND LUNGS

EXPERIMENTAL DATA AND CLINICAL RADIOTHERAPY

BY

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MAYO CLINIC

ROCHESTER, MINNESOTA

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ACTION OF ROENTGEN RAYS AND RADIUM ON THE HEART AND LUNGS

Clinical Considerations

Roentgen rays have been little used in the treatment of cardiac disorders, probably because there appeared to be no good ground for believing that they might be effective. Nevertheless, the literature contains a few reports which indicate that irradiation may have a measure of therapeutic value.

Roentgen Rays. Roentgen Therapy for Myocarditis and Angina Pectoris. Beeck and Hirsch (1916) recorded ten cases of supposed luetic myocarditis and aortitis, with or without aneurysm, and with clinical manifestations characterized by pain in the chest, radiating to one or both upper extremities and more or less simulating angina pectoris with dyspnea, fear of impending death, loss of weight, dilatation of superficial vessels in the epigastric region (one case), and inguinal lymphadenopathy (one case). The Wassermann reaction was negative in five, positive in three, but was not mentioned in the two remaining patients. The diagnosis of dilatation of the aorta and, in some instances, also of the heart, seems to have been based on the roentgenologic broadening of the mediastinal and cardiac shadows. These ten patients appear to have derived substantial benefit from having been exposed to roentgen rays[86] twelve times, at intervals of one to three weeks. The symptoms were said to have diminished or disppeared, and the improvement was represented as havin lastegd several months. If the diagnosis is assumed to have been accurate, such results are difficult to explain on the basis of any known effect of irradiation on the tissues of the heart or aorta. True aneurysm is not influenced by exposure to roentgen or radium rays, and yet in several of these patients with supposed aneurysm, the abnormal breadth of the mediastinal shadow disclosed by roentgenography was found to have diminished. This suggests that the initial increase in the mediastinal shadow may not have represented the breadth of the aorta itself. It is well known that the rather common roentgenologic diagnosis of dilatation of the aorta is often inaccurate, and should be expressed as broadening of the mediastinum. Moreover, a review of the symptoms presented by each patient gives the impression that some, at least, were probably suffering from mediastinal lymphadenopathy, which would account for their symptoms and physical findings, and which would explain the effectiveness of radiotherapy. Some similar process may also explain the improvement of one patient with supposed myocarditis, treated and reported by Förster (1922). Morlet (1922) reported having verified, in five cases of aortitis, the efficiency of irradiation against the subjective manifestations which often are so distressing to the patient, but he gave no further details. Groedel and Lossen (1923) were not able to bring about similar improvement.

But, in spite of the paucity of data in the foregoing reports, the diagnosis may have been accurate, and the favorable influence of irradiation may be quite real, though ill understood. That such a contingency is possible is shown by the report

[86] The patients treated by Beeck were exposed to roentgen rays generated by a Sanitas apparatus; those treated independently by Hirsch, to rays generated by a Polyphos apparatus, with a small type Intensiv current inductor. The quality of the rays corresponded to a parallel spark-gap of 26 mm.; the intensity was 1.4 ma.; the focal-skin distance, 22 cm.; the filtration, 3 mm. Al; 5 Holzknecht units were given at each session to either the anterior or posterior aspect of the thorax.

of Nemours and Barrieu (1928), who found that irradiation of the anterior and posterior aspects of the thorax of seven patients suffering from attacks of pain characteristic of angina pectoris, caused the crises to disappear completely in five cases, and to diminish in the other two patients. The patients were exposed to partial doses three times a week, and improvement was noted after the first or second exposure. Here, we may have another example of the analgesic effect of irradiation, the analgesia in this case probably resulting from resolution of inflammatory infiltration.

Further evidence of the beneficial effect of irradiation on certain cardiac conditions was furnished by Levy and Golden (1927), who exposed the heart of twenty patients suffering from acute or chronic, febrile or afebrile, rheumatic carditis to about 10 per cent of the erythema dose of roentgen rays of short wave-length, four times at intervals of two weeks, and this was repeated after an interval of from one to several months. Frequent electrocardiograms and numerous teleroentgenograms were made to check the clinical observations. Of the twenty cases, seventeen improved, one derived no benefit, and two died six and ten months, respectively, from the beginning of treatment. Improvement in the condition of the patient, with corresponding electrocardiographic changes, occurred in twelve cases; improvement, without electrocardiographic alteration, in five cases; the two patients who died presented electrocardiographic changes, but their condition had not improved; and the remaining patient, who had been irradiated only twice, showed neither improvement nor electrocardiographic change. Mildly unpleasant symptoms, such as malaise, headache, anorexia, nausea, vomiting, or increased pain in the chest, were noted in eight patients, but in no instance did Levy and Golden find any evidence of cardiac injury or unfavorable effect on the course of the disease. Such results suggest that the rays may act on the inflammatory deposits (infiltrating leucocytes), the resolution of which is thereby favored. This would also explain the analgesic effect of irradiation, but in the absence of conclusive evidence of such effect, this plausible interpretation must remain conjectural.

The experience of Arrillaga (1928), who treated five male and three female patients suffering from severe angina pectoris, without valvular lesions, was wholly favorable. His first patient, the wife of a physician, obtained complete relief from painful crises, and was still well when the case was described more than one year later. Similar results were obtained in the other patients, but these were more recent. The treatment was directed to the midthoracic region, through two anterior and two posterior fields, and a total of 3,528 R of roentgen rays, generated at a potential of 176 effective kilovolts with condensors, filtered through 0.5 millimeter of copper and 1 millimeter of aluminium, with 5 milliamperes of current, at a focal-skin distance of 40 centimeters, were given to the four fields in from six to ten days, and repeated after from thirty to forty days. In all the patients the crises stopped after the first course of treatment. Arrillaga thought the rays acted on the sympathetic, either by a kind of physiologic section, or by a diminution in hyperexcitability. The evidence in favor of a direct effect of roentgen rays on the autonomic nervous system to explain the analgesic effect of irradiation in many painful states is not strong; but cases are encountered in which a distinct analgesic effect is difficult to explain without implicating the sympathetic. With our present meager knowledge

of the physiology of this part of the nervous system, it is impossible to prove or disprove such relationship. Nevertheless, as information about the effect of irradiation on various tissues increases, the rôle of the sympathetic as a primary factor appears to become less and less important. It is generally invoked when some other plausible or obvious explanation cannot be given.

Roentgen Injury to the Heart. A few instances of apparent injury to the heart or cardiovascular apparatus from exposure to roentgen rays have been recorded. Coutard and Lavedan (1922), Lavedan and Monod (1922), and Lavedan (1925) drew attention to the fact that, aside from digestive disturbances and modifications of the blood, irradiation may provoke a peculiar cardiovascular syndrome characterized by shortness of breath or actual dyspnea on exertion, myasthenia, especially of the lower extremities, tachycardia or tachyarrythmia, sudden or gradual fall in blood pressure, muffling of the heart sounds, and occasionally embryocardia, functional murmurs, and duplication of the second sound. When slight, these disturbances disappear in about one month, but when severe, they may continue for a long time. They cannot be due to direct action of the rays on the heart, because, as Coutard and Lavedan have shown, they also occur when the thorax has not been exposed to radiation. In view of the large number of patients subjected to radiotherapy, it is astonishing that such disturbances should not have been reported by others. Explicit as are the observations of Coutard and Lavedan, the mechanism involved is not clear; all that can be said of them is that they do not reflect a direct and specific influence on the heart, but must be attributed to indirect factors. These disturbances, which are generally slight and of short duration, have been ascribed to protein shock, and Giraud, Giraud and Parès have apparently shown that this reaction is due to the outpouring into the circulation of albuminous products of cellular destruction.

Emery and Gordon (1925) made systematic electrocardiographic studies of a series of nine patients receiving roentgen-ray treatment over the chest for various conditions. Pathologic inspection of cardiac material from a group of eight patients whose chest had been irradiated, and from another group of patients who had been irradiated over other parts of the body, was also made. The electrocardiographic data were entirely negative except in two cases. One, who had received a total dose of 8,225 milliampere-minutes,[87] showed a slight flattening of the T wave in all three leads, but the possible significance of this finding could not be established. The patient developed dyspnea and pain in the chest, but this may have been related to extensive carcinoma of the pleura. The electrocardiograms of the other patient showed various irregularities, but physical examination before treatment had disclosed an irregular pulse. Pathologic studies gave no evidence of myocardial changes, except in the older patients, in whom fatty infiltration, splitting of muscle fibers, and sclerosis were found. No clinical symptoms of circulatory disturbance were noted. Altogether, the evidence does not suggest that roentgen rays in the doses used can cause in the myocardium temporary or permanent changes recognizable by the ordinary methods.

Gendreau (1931) made systematic electrocardiograms, before and after exposure to roentgen rays or radium, of many patients[88] treated for malignant tumors in

[87] Emery and Gordon gave this as 8,225 ma., but they undoubtedly meant milliampere-minutes.

different parts of the body (lip, tongue, cheek, neck, axilla, breast, intestine, uterus, etc.). In some cases the thorax was irradiated, but in others the chest was not exposed to the rays; some received single, large doses, while others received multiple, smaller doses at intervals. Extra P waves and impure flutter, flattening of P waves and auricular fibrillation, and abnormal QRS complexes, were common findings. Sometimes deep Q and S deflections occurred, usually when the patient was exposed to rays generated at moderate voltage. When the voltage was high (185,000 peak) the tracings were occasionally reduced to a line. The T waves were deeply inverted, sharp and rounded, and with occasional notches in the ascending branch. The R-T was constant, but the T-P was usually increased and after treatment the rhythm was slower. In premature ventricular contractions, on the contrary, the T-P was greatly reduced, and P usually followed T. Extra systoles were generally succeeded by a compensatory pause. Tachycardia was less common than bradycardia.

From the fact that such electrocardiographic eccentricities occurred as often when the heart was not as when it was exposed to the rays, it seems clear that the functional abnormalities noted cannot be regarded as anything but indirect effects. Gendreau failed to mention whether or not the patients presented clinical signs of disturbed cardiac function. Regardless of this fact, however, the knowledge acquired from the experimental data would lead one to expect slight and probably transient fatty degeneration of the myocardium as a result of cellular changes in the irradiated territory and of nutritional disturbances so commonly associated with radiotherapy. The nutritional factor alone might be sufficient to induce such vagaries. The inability of many patients to take food and the vomiting which are such frequent incidents of radiotherapy, especially when this is directed against neoplastic processes, may well affect the rhythm and efficiency of cardiac contraction, but, unless the organ is already laboring under an abnormal handicap, it is surprising how well it bears the strain. Many radiologists of large experience have never seen cardiac disorders sufficient to cause clinically perceptible symptoms, even when the thorax was exposed to relatively large doses, provided cardiac function was known to be normal before irradiation. It is quite possible that, if electrocardiographic records of every patient were made before and after treatment, similar findings might be more common, but this does not necessarily mean that irradiation places an undue strain on the cardiac mechanism; otherwise, clinical breakdown should be more frequent.

Schweitzer (1924) described the interesting case of a woman of thirty, who, having developed a congestive swelling of the face, dyspnea on exertion, irritative cough, extensive dilatation of the superficial veins of the thorax, and right pleural effusion, a diagnosis of Hodgkin's disease was made, roentgen-ray treatment was given several times during the four months of her stay in the hospital, and she received additional treatment later. For a time, the patient's condition improved, the cyanosis, venous dilatation and dyspnea disappeared, and the mediastinal tumor diminished in size; but later the symptoms returned, gradually increased in severity, and she died from asphyxia about fourteen months after her admission to the hospital. At necropsy, a shrunken, sclerotic mediastinal tumor 6 by 12 cm. was found closely adherent to the pericardium, the inner surface of which was covered

[88] Number not mentioned.

with fibrinous material; the pericardial fluid was normal in quantity, but turbid. The mediastinal tumor was dense and structureless, and extended backward to the region of the tracheal bifurcation, where it completely surrounded the ascending aorta and the right portion of the aortic arch, as well as the right carotid artery. The heart was small and the epicardium covered with fibrinous material. Dense adhesions bound the shrivelled mediastinal mass to the sternum and to the lungs, especially to the right lung, which was very small, devoid of air, and drawn toward the tumor. The pleura covering this lung was thickened and adhered firmly to the right leaf of the diaphragm. More than a liter of turbid fluid was found in the right pleural cavity. On section, dense strands of connective tissue, especially around the large bronchi, were found in both lungs. No microscopic evidence of lymphoblastoma or other tumor tissue could be found in the mediastinum or in the adjacent or distant lymph nodes. This can hardly be accepted as an example of direct injury to the heart by roentgen rays. The evidence presented points, rather, to primary injury to the pleura and lungs, which are known to be more sensitive to irradiation than the heart. But it is also probable that destruction of tumor cells and the resulting connective tissue sclerosis of the mediastinal structures played a part in the process. The condition of the pericardium and heart probably represented a secondary reaction to the severe inflammation of the adjacent pleura and lung.

Davis (1924) recorded three cases of carcinoma of the breast, in one of which the condition was inoperable, while the other two patients were subjected to radical amputation of the mammary gland and its tributary lymphatics. All three patients were treated with roentgen rays several times, and they subsequently developed respiratory disturbances, such as cough, shortness of breath, increase in pulse rate, and, in two cases, fever. Except in one patient, in whom the symptoms were acute and severe, the general condition was affected but little, if at all. The acute phase of the reaction subsided and was replaced by a chronic condition, with cough and shortness of breath on exertion as the main features. As Davis was able to demonstrate, these manifestations represented a pleuropulmonary inflammation caused by excessive doses of roentgen rays, and will be dealt with in connection with the respiratory tract. The shortness of breath and increased pulse rate in such cases are probably a measure of the respiratory embarrassment. There is no evidence that they are due to any primary effect of the rays on the heart.

Hartman, Bolliger, Doub, and Smith (1927), cited three cases, not as definite examples of cardiac injury by irradiation, but their statement that "microscopic examination of the myocardium yielded interesting changes which we felt were quite similar to those observed in our dogs[89] that had been exposed to deep X-ray" implied injury. The first patient, aged thirty-six, had extensive lymphosarcoma, with cervical and mediastinal lymphadenopathy. She received two courses of roentgen-ray treatment and died six months later. The necropsy findings included a right empyema (drained by operation), collapse of the right lung and cavitation of the upper lobes, tumor masses in the left lung, edema of the subepicardial fat, a tumor in the wall of the left auricle, atrophy of the cardiac muscle fibers, vacuolization of the interstitial tissue, and scattered vacuolar or hyaline degeneration of

[89] The dogs used in their experiments on the influence of roentgen rays on the heart (see experiments on animals).

some of the muscle fibers. The second patient, aged sixty-two, had a mediastinal tumor extending into the hilus of the left lung and causing respiratory symptoms suggestive of asthma. He was irradiated for forty-five minutes,[90] and died two months later. The necropsy revealed primary carcinoma of the pancreas, with metastasis to the retroperitoneal, mediastinal, and bronchial lymph nodes, and to the left lung. The macroscopic appearance of the heart was normal, but microscopically the cardiac muscle fibers had a frayed, fuzzy appearance, the striations were indistinct, the nuclei contained much brown pigment, and the excessive interstitial tissue was vacuolated and contained round or wandering cells. The third patient, aged twenty-three, had lymphosarcoma, with mediastinal involvement. The thorax was irradiated for 64, 26, 65, and 42 minutes respectively, on as many occasions, at intervals of from thirty-six days to almost one year, and always through several fields each time.[91] Death occurred about three and one-half months after the last irradiation. At necropsy, there were found acute fibrinous pleurisy of the right lung; erysipelas of the back, sides, neck and chest; multiple metastases to both lungs, to the mediastinum, and to the pericardium. The macroscopic appearance of the heart was essentially normal, but microscopic examination revealed atrophy of the muscle fibers and increased interstitial tissue. "Of many fibers the sarcolemma and vacuolated cytoplasm are all that remain," while others had undergone hyaline degeneration. The walls of the arterioles were thickened and surrounded by fibrous tissue. The evidence furnished in connection with these three cases is not conclusive, and most, if not all, of the abnormalities described may have been the result of disease rather than of irradiation. In the third patient, however, the thickening of the arterioles and the apparent hyperplasia of the perivascular connective tissue may well have been an effect of irradiation.

Lassueur (1927) reported himself as having been a victim for many years of radiodermatitis acquired as a radiologist by daily exposure to roentgen rays under conditions of insufficient protection. The chronic inflammation of the skin of the hands and forearms increased gradually and later was accompanied by tingling, burning, dryness of the skin, brittleness of the nails, and pain. When he ceased to expose himself, these symptoms subsided slowly, but the pain continued unabated. Later, another radiologist having opened an office for radiotherapy directly beneath that of Lassueur, the latter noticed four years later, that his radiodermatitis was again increasing, although he had adopted protective measures against rays generated by his own apparatus. The pain in the upper extremities resembled that of neuritis, and at times was violent. Seven months later he was obliged to discontinue his professional activities and go to bed. He then developed general vasomotor disturbances, and cardiovascular crises featured by vasodilator phenomena with acceleration of pulse, palpitation, and fall in blood pressure, alternating with crises of vasoconstriction, with tachycardia, bounding pulse, and relative hypertension. These became sufficiently severe to give rise to attacks of angina and loss of consciousness. Lassueur related the peripheral and cardiovascular manifestations and regarded them as results of a sensitization of the centripetal cardiac nervous paths, and as secondary to the peripheral neuritis or trophic disturbances. The direct rela-

[90] This time was divided between two or three fields; the other treatment factors were not mentioned.
[91] The other details of treatment were not given.

tion of exposure to roentgen rays, repeated daily for several years, to the manifestations described cannot be questioned. Here, however, the cardiovascular disturbances are peculiarly dependent on the special circumstances under which they were induced. As will be seen in connection with long continued irradiation of the skin, chronic hyperplasia of the epithelium and sclerotic thickening of the blood vessels, with narrowing or obliteration of the lumen, are characteristic effects. But, in the case of Lassueur, it is not clear what factors may have been responsible for the anginoid attacks, and for the other cardiac symptoms mentioned.

Radium. Radium does not appear to have ever been employed to treat diseases of the heart.

Radium Injury to the Heart. Wegelin (1927) described two cases of carcinoma of the esophagus, which had received intra-esophageally 1968.4 milligram-hours and 2160 milligram-hours of radium, respectively. Perforation of the esophagus occurred later, the patients died, and in both necropsy revealed extensive necrosis of the neighboring wall of the left ventricle of the heart. Although the report does not specify how much filtration had been used, it is obvious that it was insufficient; such accidents can generally be obviated by adequate filtration.

Renfer (1927) reported two cases of carcinoma of the esophagus treated with radium. In the first case, a man aged 57 years, the stenosis of the esophagus was 38 cm. from the incisor teeth. Two tubes, each containing 10 milligrams of radium bromide filtered through 1.5 millimeter of platinum, and two tubes, each containing 3.3 milligrams of radium bromide filtered through 1.2 millimeter of platinum, were placed in rubber catheters and inserted to a level between 34 and 44 centimeters from the incisor teeth and left in place for 74 hours. The patient died from hemorrhage five and one-half months later, after a period of progressive asthenia. Necropsy revealed necrosis and rupture of the central portion of the posterior wall of the left ventricle.

In the second case, a man aged 60 years, the esophagus was tightly stenosed 35 centimeters from the incisor teeth. Two 10 milligram tubes of radium bromide filtered through 1.5 millimeter of platinum and 2 millimeters of rubber were introduced into the esophagus and left in place for 72 hours. The patient gradually became more and more cachectic and died five months later. Necropsy disclosed necrosis of the posterior wall of the left auricle extending to the endocardium which was abnormally thick. In both cases the esophageal carcinoma had ulcerated, and the necrosed portion of the myocardium corresponded to a perforation of the parietal pericardium which adhered to the esophagus. Renfer's explanation that the radium had caused rapid destruction of the neoplastic tissue, perhaps already thinned by ulceration, and then had affected the adjacent pericardium and myocardium to the point of necrosis seems altogether logical. The initial action of the radium probably was to cause degenerative lesions in the pericardium and myocardium, including some of the blood vessels in the affected area. The injured cells probably were replaced by connective tissue, which later gave way as the result of late radiomyocarditis.

Thibaudeau and Mattick (1929) undertook to examine, microscopically, the heart[92] of ten patients suffering from malignant conditions within the chest, in whom

[92] Secured at necropsy.

the precordial region had been exposed to extensive irradiation. The heart of ten other patients, in whom the precordial area had not been irradiated, and also of four cases of malignancy in which the patients had not been subjected to radium or roentgen rays at any time, was examined in the same way. Pieces of myocardium from the wall of the left ventricle, about midway between the apex and mitral valve and along the left lateral border of the heart, were examined for degeneration of muscle fibers, necrosis, fatty changes, round cell infiltration, fragmentation of muscle fibers, fibrosis, and other degenerative abnormalities.

Of the first group of ten patients irradiated for intrathoracic malignancy, one had received 819 mc. of radon into the esophagus for epithelioma of this structure, and six days later this had been followed by roentgen irradiation[93] of the mediastinum from the anterior and posterior aspects of the thorax. Sections of myocardium showed hyaline and fatty degeneration, round cell infiltration, brown atrophy, fibrosis, and the walls of the cardiac blood vessels were abnormally thick.

The second patient received (June 24, 1920), in each of six areas (axilla), 604 mg-hr. of radium filtered through brass . . . , 1 mm. of lead, and 32 layers of gauze. On May 4, 1921, 1404 mc-hr. of radon (pack), filtered through 0.5 mm. of silver, lead[94] and 1 mm. of aluminium, was applied to anterior and posterior mediastinal fields. On February 20, 1922, 5,956 mc-hr. of radon (pack), filtered through 0.5 mm. of silver, 2 mm. of brass, and 1 mm. of aluminium, was applied to the left axilla and to the posterior aspect of the thorax. On June 27, 1923, 15,000 mc-hr. of radon, filtered as for the previous treatment, was applied over the sternum. On June 20, 1925, 5,000 mc-hr. of radon was applied, each day for six days, over the lateral base of the left lung and the upper left hypochondrium. Between September 18 and 22, 1924, an 80 per cent dose[95] of roentgen rays was given to the anterior and posterior aspects of the thorax (mediastinum). Areas of necrosis, round cell infiltration, fragmentation of muscle fibers, brown atrophy, and loss of striation were found in the myocardium.

A considerable proportion of hearts did not show any pathologic alterations. One heart showed acute degenerative changes, but, besides irradiation, the patient had also received a course of treatment with colloidal lead. In another case the heart showed definite necrosis of muscle fibers; multiple abscesses were found in the heart muscle and also in the wall of the aorta. In general, the heart of these patients presented more distinct abnormalities than those of patients whose cardiac region had not been exposed to the rays or who had not been irradiated at all. The myocardial injury was not easy to describe. Sometimes the sections had a woolly appearance, the myocardium was more fluid, the muscle fibers were separated by loose, poorly stained and edematous alveolar tissue. Groups of round cells, with occasional endothelial cells, were scattered here and there, but definite Aschoff bodies were not observed. The fibrosis, noted in the majority of irradiated hearts, was rather diffuse, did not occur in broad bands separating larger groups of muscle cells, but appeared

[93] Rays generated at 200 kilovolts and filtered through 0.5 mm. of copper; each field 10 by 15 cm.; focal-skin distance, 80 cm.; effective wave-length, 0.16 Å.; tolerance dose, 720 R.; total dose, 120 per cent, divided into six sessions of 40 per cent each; dose reaching the tumor estimated at 72 per cent.

[94] Thickness not mentioned.

[95] Rays generated at 200 kilovolts and filtered through 0.5 mm. of copper; each field 10 by 15 cm.; focal-skin distance, 80 cm.; effective wave-length, 0.16 Å.; tolerance dose, 720 R.; total dose, 120 per cent, divided into six sessions of 40 per cent each; dose reaching the tumor estimated at 72 per cent.

as fine strands between individual fibers. Also, the fibrous tissue surrounding the small blood vessels had markedly increased. In addition to the necrosis and to the hyaline and fatty changes noted in some cases, the cross striations of the muscle fibers were less distinct, the fibrils were frequently separated, some of the fibers were broken, and many stained unevenly. The nucleus of the muscle cells also stained irregularly.

In the second group of cases, in which only regions remote from the heart had been irradiated, fewer and less pronounced myocardial alterations were found. The muscle fibers did not have a woolly appearance, the striations were more distinct, and the cells stained more evenly. Fibrosis, though frequently observed, was of the usual type, and edema was less obvious.

In the third group of cases which had not been exposed to roentgen rays, the myocardial lesions "were not remarkable" and did not present an exceptional character. Fibrosis was of the usual type. An appreciable or considerable degree of brown atrophy was often noted; this is common in the heart of patients dying from malignant neoplasms. Thibaudeau and Mattick concluded that irradiation of the human heart may cause definite myocardial injury, varying from fatty and hyaline degeneration, and necrosis of muscle fibers to slight interstitial fibrosis.

Most of the patients in question had been exposed to radium, and some to roentgen rays also. At least one had also received injections of colloidal lead. In some cases, radium had been introduced into the esophagus, where it was in comparatively close relation to the heart. In other cases, radium had been applied over the anterior and posterior (mediastinal) surfaces of the thorax, and in at least one of the patients, whose treatment was described, the exposure to radium had been repeated. Under the circumstances, it is impossible to say which of the different factors may have played the major rôle in causing the pathologic changes mentioned; nor is it possible to determine what proportion of such effects may have been due to direct, and what proportion to indirect, action of the rays. It is not even clear that all the conditions found were necessarily related to irradiation, although it is probable that most of them were, at least indirectly. It must undoubtedly be assumed that the increase in fibrous tissue around the small blood vessels resulted from a direct influence of the rays on the blood vessels themselves, but the description is not altogether clear.

Conclusions

The animal experiments indicate that the specific radiosensitiveness of the heart is relatively low, much lower than that of many other structures, and that the organ is able to tolerate doses of roentgen rays well beyond the range usually employed in the treatment of human beings. Like other organs, however, the heart is not altogether insensitive to radiation and may be injured by doses of sufficient strength, as appears to have been shown by the experiments of Hartman, Bolliger, Doub, and Smith. Evidence of such injury is to be found in the degenerative and later proliferative changes in the blood vessels. Some of the abnormalities in the heart, noted under experimental conditions, appear to be secondary to acute inflammatory changes induced by irradiation in the lungs, which are more susceptible to radiation injury than the heart. The degenerative changes in the heart, noted in

most of the experiments, were probably secondary and incident to the circulation through the organ of toxic products of cellular degeneration induced in more sensitive structures and tissues by irradiation, and to accompanying disturbances of nutrition. The fall in blood pressure, the arrest of cardiac contraction in systole, and the accompanying constriction of the bronchial muscles, tonic contraction of the uterus, and increase in tone of the intestine do not appear to represent effects of irradiation, but, as shown by Stephens and Florey, were undoubtedly electrical effects unrelated to roentgen rays. The retarding effect on growth of the rapidly developing heart of young animals (embryos) appears to be secondary to the general inhibition of growth of the organism as a whole rather than to a specific action of the rays on the heart itself. In spite of such growth inhibition, however, irradiation seems to have but little influence on the contraction of embryonic cardiac muscle. This in itself shows the exceptional ability of the organ to tolerate irradiation.

Under ordinary therapeutic conditions roentgen rays do not appear to have any direct influence on cardiac function; in the few cases which have been recorded as examples of such effect, the functional disturbances probably were secondary to the gastrointestinal reaction to irradiation or to the circulation of toxic products of cellular degeneration induced by the rays.

Injection into the body of small doses of radium in solution causes degenerative alterations in the myocardium, and these also appear to be secondary to the action of the rays on remote organs. Evidence of such effects is to be found in the degenerative and hemorrhagic changes occurring, under these conditions, in the intestine and kidney, through which the injected radioactive substance is largely excreted. Roentgen irradiation has been shown to have definite therapeutic value in certain cases of angina pectoris and certain varieties of myocarditis and aortitis. The painful crises diminish or disappear altogether, and this effect may last for some time. A few instances of apparent injury to the heart from irradiation have been reported, but the evidence indicates that such effects must be ascribed to indirect factors, such as injury to the pleura and lungs or to the circulation of toxic products of cellular degeneration induced by the rays in other organs.

BLOOD PRESSURE

General Considerations

The claim has often been made that exposure to roentgen or radium rays tends to reduce blood pressure, and this claim has led certain physicians to advocate the use of radiotherapy for hypertension or to ascribe to radiotherapy an undesirable influence on blood pressure in certain cases. That phase of the subject which deals with the action of radiation on the suprarenal gland as a factor influencing blood pressure will be considered elsewhere. Only the effect of irradiation on blood pressure independent of the suprarenal will be alluded to here.

Animal Experiments

Roentgen Rays. SWANN (1924),[96] attempted to determine the immediate functional effect of roentgen rays on various organs and tissues by exposing, usually, the entire body of an

[96] For a more detailed description see page 4.

unspecified number of cats, guinea pigs, and rabbits, to unfiltered rays of medium quality[97] for varying periods. A marked and progressive fall in blood pressure, recorded continuously by a mercurial manometer, was noted after three or four fifteen-minute exposures of the thorax and abdomen, broken by short intervals of rest. In several experiments the animal died after the second exposure; death was never due to respiratory failure, because life could not be prolonged by artificial respiration, and respiration continued for some time after the heart had ceased to beat. In every instance the immediate cause of death was cardiac failure. No such effects were observed in any of the control experiments. The early fall in blood pressure did not seem to be due to a diminution in cardiac output, since the heart appeared to beat more vigorously than the normal organ. Respiration was increased in depth and frequency at first, but later marked respiratory depression occurred. On investigating the possibility of a reflex action of the rays on the sensory nerve endings, Swann found that stronger and stronger faradic currents were required to produce the same increase in respiration, which, after prolonged exposure, was always depressed. Experiments on the influence of irradiation on the isolated heart of frogs gave negative results, but similar experiments on the heart of rabbits appeared to show that the first effect of exposure to the rays was to increase the amplitude of contraction and sometimes to increase diastole. Irradiation for more than fifteen minutes was followed by diminished contraction, but when exposed for a longer time the tone of the muscle increased gradually until, after about three hours of interrupted irradiation, the organ ceased to beat in systole. This was accompanied by constriction of the bronchial muscles, tonic contraction of the uterus, and increase in the tone of the intestine.

Strauss and Rother (1924) first determined the blood pressure of rabbits by placing a glass cannula in the carotid on one side and by recording the pressure on a rotating drum. The average maximum pressure of an unspecified number of animals was from 70 to 75 millimeters of Hg, and the average minimum pressure from 60 to 65 mm. Hg. Keeping the animals bound for several hours had only a slight influence on blood pressure. Restless movements always caused the pressure to rise slightly, but it soon returned to the normal level. After the animals had been bound for two hours, the maximum pressure fell 5 mm. and the minimum pressure 10 mm. The upper abdomen of an unspecified number of fresh animals was exposed to one erythema skin dose of roentgen rays of short wave-length.[98] The blood pressure of a rabbit which, before irradiation, was 70/60 mm., fell at the beginning of irradiation to 67/55, at the end of exposure to 60/40, and one and one-fourth hours after irradiation to 50/30. Two hours later the maximum pressure had diminished to 30 mm. Hg, while the minimum pressure could not be determined. The blood pressure of another rabbit remained unaffected during the period of exposure, but fell immediately afterward from 70/60 to 67/55; after one and one-fourth hours, to 50/30; it rose again after two hours to 55/35 and after two and one-half hours to 60/45, and was still subnormal three days after irradiation.

Assuming that, if irradiation acted through the sympathetic, the blood-pressure changes described should not occur when the sympathetic was paralyzed by a suitable toxin, such as atropin, rabbits were exposed to the rays after subcutaneous injection of 0.01 gm. of atropin. The blood pressure of one rabbit, which was 75/67 at the outset, was 70/65 twenty minutes later. At the end of irradiation the pressure was 67/60; one and one-fourth hours later, 67/60; and two hours later, 70/60. A second experiment gave similar results. Irradiation under these conditions had no perceptible effect on the blood pressure. Thinking that the sensitiveness of the skin might influence the action of the rays, the skin over the abdomen

[97] The rays were generated by gas tubes of the same make, operated at a potential equivalent to a point-plate spark-gap of from 4 to 7 inches; the focal-skin distance varied between 6 and 10 inches, and the intensity of the current between 1 and 2 milliamperes.

[98] 200 peak kilovolts; filtration, 0.5 mm. Cu and 3 mm. Al; 2 ma.; focal-skin distance, 25 cm.

of another rabbit was incised and reflected, so that the entire region could be irradiated without any intervening skin. The pressure of this animal, which was 70/60 before exposure, fell to 67/57 at the end of irradiation, to 65/55 after one and one-fourth hours, and to 60/50 after two and one-half hours. The effect of irradiating the skin alone was next investigated. Two long, lateral, and parallel incisions were made in the skin of the abdomen, and a lead plate covered with sterile gauze was passed from side to side, under the longitudinal bridge of abdominal skin; in this way the abdominal organs were protected from irradiation. It was admitted that the skin of the abdomen was no longer normal, because important nerve structures had necessarily been divided. The blood pressure of the rabbit now was 70/55; after irradiation of the isolated skin it fell to 65/50; one and one-half hours later, to 60/40. No definite conclusions were drawn.

STEPHENS and FLOREY (1927), stimulated by the experiments of Swann, which appeared to show that "X-rays cause a gradual and regular fall of mean blood pressure," undertook to determine if, under any conditions, exposure to roentgen rays induces the appearance of a depressor substance in the circulation. The entire body of an intact rabbit was irradiated[99] without anesthesia for seven hours, the exposure being interrupted for a few minutes from time to time. Blood was then collected from the ear vein and heparin was used to prevent clotting; blood from a normal rabbit was collected as a control. From a third animal a blood-pressure tracing was taken from the carotid, after 5 c.c. of blood from the normal rabbit had been injected into the ear vein. The blood pressure fell momentarily 5 mm., but the pressure immediately returned to its former value; this slight change was ascribed to the act of injection, because a similar change followed the injection of normal saline. An identical effect was produced by injecting 5 c.c. of blood from the irradiated animal. Evidence of a depressor substance not having been obtained, it was thought that the fall in blood pressure noted by Swann might have been due to anesthesia. An animal anesthetized with urethane was therefore irradiated[99] for three hours, and a heparinized sample of blood tested in the same way, but the blood pressure was not perceptibly influenced. After such prolonged irradiation the animals appeared to be in normal condition.

The death of a rabbit after irradiation for ten minutes, as described by Swann, pointed to some factor besides roentgen rays. In Swann's experiments the entirely unprotected animals had been placed at a distance of from ½ to 2 inches from the tube. Electrical leakage through the animal from the tube and high-tension leads was inevitable, especially with the animal lying on a copper table. To obviate this source of error, a metal box, with a window of aluminium foil 0.005 mm. thick immediately above the animal, was used as an electrical screen. In this electrical screen was placed an urethanized rabbit, and a record of its blood pressure was taken from the carotid artery. The rabbit was then irradiated continuously for one-half hour; instead of showing the expected fall, the blood pressure had risen to 10 mm. Further irradiation for one-half hour, without the electrical screen, was accompanied by a slight continuous fall in pressure. This was repeated six times with identical results. Moreover, it was impossible to cause a marked fall in blood pressure, even when the electrical screen was removed.

Stephens and Florey found it impossible to influence the respiration of a rabbit anesthetized with urethane and irradiated continuously for one hour, partly with and partly without the electrical screen. Nor did they observe any notable effect on the spleen and heart of young cats irradiated for from one and three-quarter to four hours through celluloid windows inserted and sutured into the thoracic and abdominal walls. A description of this phase of the experiments will be found on page 11. They were forced to conclude, therefore, that the

[99] Rays generated by a gas tube operating at a potential equivalent to a spark-gap of 12 cm., with 2 ma. of current, at a focal-skin distance of 13 cm. Only a layer of cardboard 0.5 mm. thick intervened between the animal and the tube.

results obtained by Swann were due to high-tension electrical discharges and not to roentgen rays.

Radium. Sudhoff and Wild (1913) investigated the effect on blood pressure of injecting thorium X into four rabbits.[100] The pressure was determined by the method of E. C. Van Leersum. The carotid was freed from the surrounding tissues and a portion of the vessel was sutured into a tube of skin. The method permits frequent estimations of pressure, but has the disadvantage of allowing only the maximum pressure to be determined. The band was attached to a Riva-Rocci mercury manometer and the moment the carotid pulse disappeared was ascertained by palpation. The animals were always placed on the right side, because the dorsal position was found to give rise to unaccountable variations in pressure. The animals were kept in this position for five minutes until they were perfectly quiet before the blood-pressure measurements were started. This was essential, because the slightest noise or change of position caused the pressure to increase as much as 20 mm. Hg. During the test measurements the same investigator controlled the pump and read the manometer, while the other palpated the pulse and signalled the moment of its disappearance. The mercury was pumped slowly so that the smallest and last pulse wave could be perceived. Ten pressure readings were made during each test period of ten minutes; these were added and divided by ten to obtain the average.

Preliminary measurements of the blood pressure of an active and nervous female rabbit gave an average maximum reading of 109 mm. Hg. Several days later, 17 c.c. of a solution of thorium X, corresponding in gamma activity to 1.849 milligrams of $RaBr_2$ (0.91 milligrams of $RaBr_2$ per kg. of body weight), were injected subcutaneously. This was followed during the next few hours by a rapid rise in blood pressure, which remained high for two days, and then fell rapidly to unmeasurable values. The heart beat became weak and irregular, the respiration ranged between 104 and 98, and the animal died five days after the injection. Preliminary measurements of the blood pressure of a second female rabbit, whose condition was not good and which gave the impression of being tired and sick,[101] gave an average maximum between 85 and 95.2 mm. Hg. The next day, 7.5 c.c. of a solution of thorium X, with a gamma activity corresponding to 0.9135 milligrams of $RaBr_2$ (0.8418 mg. $RaBr_2$ per kg. of body weight), were injected subcutaneously. The blood pressure rose immediately, fell to normal the next day, and the animal died three days after the injection. Necropsy showed marked hyperemia of the mesentery and small intestine, which was filled with watery material mixed with large bubbles of gas. The upper part of the large intestine was filled with feces, but the lower portion was collapsed and firmly contracted. Small hemorrhages in the kidneys and a small, hemorrhagic infarct in the right lung were noted.

Preliminary measurements of the blood pressure of a third, male rabbit (neck ulcerated) gave a normal pressure curve between 84.5 and 86.3 mm. Hg. The next day, this animal received subcutaneously 2 c.c. of a solution of thorium X with a gamma activity equivalent to 0.108 milligrams of $RaBr_2$ (0.0486 mg. of $RaBr_2$ per kg. of body weight). The blood pressure rose, fell below normal, and rose again, but did not reach the normal level. One week after the first injection, 3 c.c. of a solution of thorium X, with a gamma activity equivalent to 0.097 milligrams of $RaBr_2$ (0.0399 mg. $RaBr_2$ per kg. of body weight), were injected subcutaneously. The blood pressure reacted to this second injection as to the first. Two days after the second injection, 3 c.c. of physiologic saline solution were injected subcutaneously, but this had no perceptible effect on the pressure. Three days later, 3 c.c. of thorium X solution, with a gamma activity equivalent to 0.119 mg. of $RaBr_2$ (0.566 mg. $RaBr_2$ per kg. of body weight), were injected subcutaneously. The blood pressure rose, fell, and recovered as after the previous injections, and the animal died sixty-three days after the last injection.

[100] A greater number of animals may have been used, but the findings given concerned only four.

[101] Several other animals had failed to survive the operation.

Necropsy[102] again revealed marked dilatation of blood vessels and hemorrhages in the heart and kidneys. Preliminary measurements of the blood pressure of a fourth, male rabbit (back ulcerated) gave an average maximum between 86.3 and 87.7 mm. Hg. The next day, 3.5 c.c. of thorium X solution, with a gamma activity equivalent to 0.3 milligrams of $RaBr_2$ (0.140 mg. $RaBr_2$ per kg. of body weight), were injected subcutaneously. The blood pressure again rose, fell, and recovered. Two weeks after the first dose, 3 c.c. of thorium X solution, with a gamma activity equivalent to 0.087 milligrams of $RaBr_2$ (0.0494 mg. $RaBr_2$ per kg. of body weight), and one week later 3 c.c. of thorium X solution, with a gamma activity equivalent to 0.119 milligrams of $RaBr_2$ (0.07 mg. $RaBr_2$ per kg. of body weight), were injected. The blood pressure had not returned to normal when the animal died sixteen days after the last injection. Necropsy again disclosed marked dilatation of blood vessels, hemorrhages in various organs, and diminished chromation of the medullary portion of the suprarenal.

Sudhoff and Wild concluded that subcutaneous injection of lethal doses of thorium X is followed by an immediate rise succeeded by a marked fall in blood pressure; that injection of smaller doses is followed by a similar, though less pronounced, reaction, with tendency to recovery; and that the degree of reaction varies with the dose, but they did not venture to analyze the mechanism of such reaction.

Analysis of Animal Experiments

Roentgen Rays. The experimental results obtained by Strauss and Rother (1924) are not susceptible of precise evaluation, because their report fails to give essential data, such as the size and anatomical limits of the field of irradiation. Nevertheless, they indicate that the fall in blood pressure after exposure of the upper part of the abdomen to roentgen rays was secondarily due to gastrointestinal reaction and the accompanying systemic depression induced by irradiation rather than to a direct action of the rays on the sympathetic nervous system. Any disturbance in the splanchnic sympathetic was probably a result, and not the cause, of the gastrointestinal reaction. These deductions are not made on the evidence furnished by Strauss and Rother, because they failed to mention any clinical manifestations; they are based on our knowledge of the relative radiosensitiveness of the intestine and of the known tendency of irradiation of the upper half of the abdomen to cause so-called radiation sickness of a more pronounced grade than irradiation of any other part of the body. Strauss and Rother did not attempt to interpret their results, probably because it would have been difficult to explain why the blood pressure fell as much after irradiation of the skin of the abdomen, with the abdominal organs themselves shielded from the rays, as after paralysis of the sympathetic by injection of atropin. The absence of control experiments increases the difficulty of close analysis.

As was pointed out in the section on the heart, the results reported by Swann suggest the possibility that they may have been due to something besides irradiation. The death of one rabbit, after irradiation for ten minutes under the conditions stated, would be difficult to understand if Stephens and Florey had not furnished an adequate explanation by demonstrating that the findings of Swann were apparently the result of high-tension electrical discharges and had little if anything to do with roentgen rays. This would also account for the peculiar constriction of the bronchial muscles, tonic contraction of the uterus, and increase in the tone of

[102] Findings reported by Salle and von Domarus.

the intestine noted by Swann- observations which seem to be doubtfully related to irradiation. When the possible influence of electrical discharges had been excluded by a suitable electrical screen, Stephens and Florey found that irradiation had no appreciable effect on blood pressure, and only a slight, continuous fall in pressure was observed when the electrical screen was not used. Therefore, Swann's contention that exposure to roentgen rays causes a gradual and regular fall in blood pressure can hardly be sustained until fresh and more satisfactory evidence is submitted.

On the whole it seems clear that any influence which irradiation may have on blood pressure is not a direct and specific effect, but is secondary to the systemic reaction and depression which so commonly follows exposure to roentgen rays.

Radium. The experiments of Sudhoff and Wild (1913) showed that the subcutaneous injection of thorium X caused the blood pressure to rise in a few hours, to remain abnormally high for from one to several days, when the pressure became subnormal and the animals died. Necropsy usually disclosed hyperemia and edema of the small intestine and hemorrhages in the kidneys and other organs. Solutions of radium or its products, when injected into the body, are excreted largely through the intestine and kidneys, and strong doses are prone to induce manifestations and lesions such as those described. In view of such disturbances, it is not surprising that the systemic depression associated with them should be accompanied by the recorded variations in blood pressure; these variations are precisely those which might be expected under the circumstances. But plausibility is not proof, and more conclusive evidence will be required to remove all uncertainty.

Clinical Considerations

Roentgen Rays. Irradiation of the region occupied by the suprarenal glands has been claimed to diminish blood pressure, and most of the writings on the influence of roentgen and radium rays on blood pressure have ascribed the fall in pressure to a direct effect of the rays on this gland. Other writers, however, have claimed that exposure to roentgen rays causes the blood pressure to fall, irrespective of the suprarenal. Thus, Wolmershäuser (1923–1924) reported that of ninety patients suffering from carcinoma of the breast, fibromyoma uteri, or climacteric hemorrhage, which were exposed to roentgen irradiation, a distinct fall in blood pressure was noted in 75 per cent. In many cases the pressure fell from 20 to 50 millimeters. In control cases treated in the same manner, but without irradiation, the blood pressure sometimes diminished, but never beyond the limits of experimental error. Wolmershäuser thus excluded the possibility of noxious gases as a factor influencing the blood pressure. The fall in pressure was generally proportional to the dose of roentgen rays. In a few patients the pressure actually increased, and this was related to the vomiting induced by irradiation or to psychoneurosis. The remainder of the patients received small doses, and the blood pressure did not vary beyond physiologic limits. The conclusion of Wolmershäuser that the frequent fall in blood pressure was to be attributed to a direct stimulation of the vagus is difficult to accept, especially since experimental evidence of such an effect is wholly lacking. It appears much more probable that the decrease in blood pressure was a manifestation of systemic depression secondary to the anorexia, nausea, and vomiting caused by irradiation. This may or may not have been increased by direct action of the rays on the in-

testine. Desjardins and Marquis (1924) also studied the effect of high-voltage roentgen rays on the blood pressure of fifty-five patients with malignant tumors in different regions; they found that, in many patients, the pressure fell after each session or a full course of treatment, but the variations observed were never great and could be readily accounted for by the relaxed position of the patient during irradiation for an hour or more, and especially by the general metabolic slump incident to radiation sickness. This also applies to the results obtained by Schroeder (1924) and Panow (1926), which paralleled closely those of Wolmershäuser. Wigoder (1927) had much the same experience and soundly attributed the fall in pressure to a depression of the vasomotor centers by toxins liberated as the result of cellular degeneration caused by irradiation. In support of this interpretation, Wigoder stated that the fall in blood pressure was greatest in cachectic patients and in those irradiated over the abdomen. Mazzanti (1928) also noted an almost constant fall in blood pressure in 100 patients irradiated over different parts of the body for various conditions. Sex and the region exposed appeared to be of little importance; children were more sensitive; the chief factors, however, were the dose of radiation and the area of surface exposed. Mazzanti thought the sympathetic nervous system implicated, but held that the fall in blood pressure was mainly due to the circulation of toxic products of cellular degeneration.

Bucky (1928) was unable to obtain extra-physiologic variations in blood pressure by exposing the skin of different regions to low-voltage, or so-called "grenz," rays.

Radium. Müller claimed that radium baths or inhalation of radium emanation caused the blood pressure to fall, and reported one patient treated in this manner with apparent benefit; but the data furnished were meager and of little value. Enriques (1927) advanced the idea that, in cases of hypertension, exposure to radium of the basal ganglia of the brain was followed by a reduction of the systolic, diastolic, and pulse pressures, with accompanying partial or complete relief from symptoms. The data submitted by him, however, rested on only one case and were inconclusive.

Conclusions

The animal experiments indicate that roentgen rays do not exert any direct and specific influence on blood pressure, but that irradiation may cause an indirect fall in pressure as a secondary result of the general systemic reaction and depression which commonly follows exposure to the rays under certain conditions. The effect of exposure to radium under comparable conditions would probably be much the same. Where radium or its disintegration products are injected into the tissues, however, the radioactive substance is excreted largely through the gastrointestinal tract and kidneys, and these structures may undergo varying degrees of reactive inflammation. This probably explains the initial rise and subsequent fall in blood pressure noted by Sudhoff and Wild.

The evidence furnished by clinical observation also indicates that the decrease in blood pressure sometimes found after irradiation manifests the systemic depression resulting from exposure to the rays, or, as expressed by Wigoder, represents a depression of the vasomotor centers by the toxic products of cellular degeneration caused by the rays. In any event, such fall in pressure as may occur is an indirect and not a direct or primary effect. There appears to be little ground for the idea that radiotherapy may be useful to counteract or correct hypertension.

SUPPLEMENTARY NOTE

To those who have had the patience to read the articles bearing on the action of roentgen rays and radium on the eye and ear I have to make apology. In connection with the radio-sensitiveness of the lens, I have been guilty of a serious error, and I hasten to rectify the error as much as may be possible. My statements, in those articles, concerning the facility with which relatively small doses of roentgen rays may induce cataract in the rapidly developing lens of young animals irradiated soon after birth are fully warranted by the experimental evidence. Where I erred was in relation to the radio-sensitiveness of the lens of adult animals. The particular article in which this point was discussed plainly states that, whereas the rapidly developing lens of young animals is quite sensitive to irradiation, the mature lens of adult animals is much more resistant and can tolerate doses several times greater than those ordinarily employed in clinical radiotherapy. In the light of the experiments included in that article, this seemed to be the only deduction which could be made.

At the time, unfortunately, I had failed to discover more recent experiments by Rohrschneider, Peter, and others, as well as clinical reports of lenticular opacification following irradiation, which have forced me to alter my deductions radically. This hitherto undiscovered evidence shows quite clearly that, while the mature lens of adult animals is distinctly less sensitive to irradiation than the lens of young animals irradiated soon after birth, its limit of tolerance slightly exceeds that of the conjunctiva, but not nearly to the degree indicated in my article. Hence, as far as the relative sensitiveness of different ocular elements is concerned, the lens comes next to the conjunctiva and lids. In fact, the difference in susceptibility of the conjunctiva and lens does not appear great. The logical conclusion therefore, is that exposure of the eye to doses sufficient to cause inflammatory reaction in the conjunctiva and lids, especially if such doses are repeated, may lead to cataract. Moreover, such opacification of the lens may not become apparent for from three months to two years or more.

I am deeply chagrined by the knowledge that what I have written may have misled many into a false sense of security with reference to the structure in question. The only possible excuse is that the preparation of these articles involves such extensive consultation and minute examination of experimental and clinical records that an occasional slip is almost bound to occur.

A. U. Desjardins